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FINAL RCRA
FACILITY INVESTIGATION REPORT
FOR ZONE H
NAVAL BASE CHARLESTON

VOLUME II
SECTIONS 5-6

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5.0 FATE AND TRANSPORT

Fate and transport assessments evaluate what is known regarding the presence of constituents in the environment based on inherent characteristics of constituents and the environmental media in which they reside. Specifically, fate and transport assessment seeks to evaluate a constituent's ability to become mobile or change in the environment. To accomplish this, the chemical and physical properties that govern the constituent's interaction within environmental media must be understood. From a macroscopic viewpoint, the characteristics of the site — topography, climate, geography, and geology — play a role in erosional transport processes. From a microscopic viewpoint, the characteristics of site soil, sediment, and water, as well as the constituent's chemical and physical properties, play roles in evaluating the processes of advection, diffusion, and dispersion which move a constituent between media or place to place within a medium. The fate and transport discussion will help to identify potential receptors resulting from constituent movement in the environment.

Evaluation of Zone H with regard to the above characteristics identified four potential routes of constituent migration:

- Air emissions resulting from VOCs released from surface soil.
- The leaching of constituents from soil to groundwater.
- Surface soil erosion and runoff of constituents into adjacent depositional zones.
- The migration of constituents from shallow groundwater into surface water bodies.

As mentioned above, the significant processes of constituent migration include erosion, advection, diffusion, and dispersion and are defined as follows:

Erosion

In the context of surface and subsurface contaminant transport, erosion is the process by which particles are suspended by the physical action of water and are subsequently moved in this manner. Compounds sorbed to particulate material move along with the that material.

Advection

Advection is the process by which dissolved substances migrate with flowing groundwater. Hydraulic conductivity, effective porosity, average linear velocity, and hydraulic gradient are variables which determine the chemical's rate of movement by the advective transport process. This characteristic is significant for compounds associated with groundwater.

Diffusion

Diffusion is the process by which solutes are transported from a region of high concentration to a region of low concentration. In very fine sediments with very slow hydraulic conductivities, diffusive transport may be the dominant mode of migration.

Dispersion

Dispersion is the hydrodynamic process by which solutes are mixed with uncontaminated water, diluted, and transported preferentially due to the heterogeneous properties of the aquifer.

5.1 Properties Affecting Fate and Transport

Numerous chemical and physical properties of both the constituent and the surrounding media are used to evaluate fate and transport mechanisms.

5.1.1 Chemical and Physical Properties Affecting Fate and Transport

Chemical and physical properties used to evaluate fate and transport include vapor pressure, density, solubility, half-life, Henry's law constant, octonal/water partitioning coefficient, organic carbon/water partitioning coefficient, and molecular weight. Table 5.1.1 provides an overview of chemical property behavior based on these properties.

Table 5.2.1 contains chemical and physical property data for each compound detected in the Zone H samples. SWMU- or AOC-specific fate and transport, migration pathways, and potential receptors are discussed in Sections 5.3 through 5.19.

Compounds with similar chemical and physical properties also display similar fate and transport mechanisms. This facilitates the general grouping of contaminants based on chemical and physical properties into the following categories: VOCs, SVOCs, pesticides/PCBs, chlorinated herbicides, chlorinated dibenzodioxins/dibenzofurans, and inorganics.

VOCs

The chemical and physical properties with the greatest influence on the fate and transport of VOCs are solubility, Henry's law constant, and vapor pressure. Typical fate and transport characteristics of VOCs are:

- They can leach from soil into groundwater.
- They tend to be highly mobile in both soil and groundwater.
- They tend to volatilize from both soil and groundwater.
- They tend to dissipate relatively quickly.

VOCs have low molecular weights, moderate densities and Henry's law constants, varying octanol/water partioning coefficients and organic carbon/water partioning coefficients, and high solubilities and vapor pressures. Overall, VOCs are expected to be moderately to highly mobile in the environment and to be relatively quick in attenuating from soil and groundwater.

SVOCs

The chemical and physical properties with the greatest influence on the fate and transport of SVOCs are solubility, vapor pressure, octanol/water partitioning coefficient, and organic carbon/water partioning coefficient. Typical fate and transport characteristics of SVOCs are:

- They tend to sorb to soil particles.
- They tend to be immobile in the environment.
- They movement tends to occur more often by colloidal suspension than by diffusion (i.e., greater mobility occurs when coupled with "carrier" compounds).

SVOCs have high molecular weights, wide ranging vapor pressures, solubilities, and Henry's law constants, moderate to high densities, and generally high octanol/water partioning coefficients and organic carbon/water partitioning coefficients. Overall, SVOCs are expected to be relatively immobile in soil and diffuse only slightly to groundwater. The most notable exception to the anticipated immobility of SVOCs in the environment is phenols, and substituted phenols, which have higher solubilities.

Pesticides/PCBs

The chemical and physical properties with the greatest influence on the fate and transport of pesticides/PCBs are solubility, Henry's law constant, octanol/water partioning coefficient, and organic carbon/water partioning coefficient. Typical fate and transport characteristics of pesticides/PCBs are:

- They tend to sorb to soil particles.
- They tend to be hydrophobic (avoid water).
- They tend to be immobile in the environment.
- They tend to degrade relatively slowly.

Pesticides/PCBs have moderate molecular weights; generally high densities, octanol/water partioning coefficients, and organic carbon/water partioning coefficients, and generally low solubilities, vapor pressures, and Henry's law constants. Overall, pesticides/PCBs are anticipated to be immobile and persistent in the environment, not readily diffusing into groundwater.

Chlorinated Herbicides

The chemical property with the greatest influence on the fate and transport of chlorinated herbicides is solubility. Typical fate and transport characteristics of chlorinated herbicides are:

- They can leach from to soil particles to groundwater.
- They tend to be mobile in both soil and groundwater.
- They tend to degrade relatively slowly.

Chlorinated herbicides have low Henry's law constants and vapor pressures, and moderate molecular weights, octanol/water partitioning coefficients, organic carbon/water partioning coefficients, and solubilities. Overall, chlorinated herbicides are expected to be moderately mobile in groundwater with some retention in soil.

Chlorinated Dibenzodioxins/Dibenzofurans

The chemical and physical properties with the greatest influence on the fate and transport of chlorinated dibenzodioxins/dibenzofurans are solubility, Henry's law constant, octanol/water partioning coefficient, and organic carbon/water partioning coefficient. Typical fate and transport characteristics of chlorinated dibenzodioxins/dibenzofurans are:

- They tend to sorb to soil particles.
- They tend to be hydrophobic (avoid water).
- They tend to be immobile in the environment.
- They tend to degrade relatively slowly.

Chlorinated dibenzodioxins/dibenzofurans exhibit limited mobility in most environmental settings, have a strong affinity for soil particles and organic matter, and are not expected to leach to groundwater.

Inorganics

The chemical property with the greatest influence on the fate and transport of inorganics is solubility. Typical fate and transport characteristics of inorganics are:

- They tend to sorb to soil particles.
- They are not degradable.
- They tend to have moderate to low mobility; however, in acidic environments ($pH < 5$), inorganics can become mobile.

Properties of the surrounding environmental media tend to dictate the solubility of inorganics. Overall, inorganics are anticipated to be immobile and to remain sorbed to soil particles, not readily diffusing into groundwater.

5.1.2 Media Properties Affecting Fate and Transport

The properties of environmental media used to evaluate fate and transport are TOC, soil sorptive capacity, cation exchange capacity, redox conditions, pH, soil type, and retardation rate. The following is a brief discussion of these properties.

Total Organic Carbon (f_{oc})

The measure of the TOC in soil indicates its adsorptive capabilities. The higher the f_{oc}, the higher the potential for a chemical to sorb to soil particles.

Normalized Partition Coefficient (K_d)

K_d is used to predict the capacity for a constituent to partition between soil and water. To estimate K_d, the constituent's organic carbon/water partioning coefficient (k_{oc}) is adjusted by the soil's organic carbon content (f_{oc}). Higher K_ds indicate a higher potential to sorb organic compounds.

Cation Exchange Capacity

Cation exchange capacity (CEC) reflects the soil's capacity to adsorb ions by neutralizing an ionic deficiency on its surface. Generally, trivalent ions are preferentially adsorbed to soil over divalent ions, and divalent ions are preferentially adsorbed over monovalent ions. Although this is generally the case, the process also depends on soil pH. Soil with high CEC values has the potential to adsorb inorganic ions, although organic compounds with dipole moments also are affected by CEC.

Redox Conditions

Redox is the process which includes oxidation (the loss of electrons), and reduction (the gain of electrons). The resulting change in oxidation state generates products that are different from the reactants in their solubilities, toxicities, reactivities, and mobilities. Primarily, redox reactions influence the mobility of inorganic chemicals. Extreme redox conditions tend to mobilize chemicals, especially inorganics.

pH

pH is a logarithmic measure of hydrogen ions in the soil or groundwater, indicating the medium's acidity or basicity. Chemicals react significantly different under changing pHs. Low pH conditions tend to mobilize chemicals, especially inorganics, while high pH condition may lead to the formation of immobile metal hydroxides.

Soil Type

The mineralogical composition, particle size distribution, and organic content of soil influence the fate and transport of chemicals. Soil type dictates hydraulic conductivity, effective porosity, average linear velocity, and hydraulic gradient which, in turn, affect groundwater flow.

Retardation Factor (R)

The retardation factor is used to evaluate the ability for soil or groundwater to inhibit the movement of a chemical by preferentially binding to contaminants with high organic carbon/water partitioning coefficients.

Table 5.1.2 summarizes physical parameter data for soil samples collected from areas where impacts were apparent based on the first two phases of sampling. These samples were collected to provide data to assess fate and transport and possible treatment alternatives for these affected areas. Table 5.1.3 summarizes pertinent fate and transport data resulting from Shelby tube analysis performed on samples collected during monitoring well installation activities. Appendices F, I and M contain a complete set of analytical data used to prepare these tables. The summary tables are provided as a general overview of soil physical characteristics in Zone H. In instances where detailed fate and transport assessment was necessary, site-specific information was considered.

The average porosity of the upper sand interval in Zone H, as determined through Shelby tube analysis, was 37%. Hydraulic conductivity, as determined by shallow well slug test data analysis (Table 3.3), is 1.05 feet/day. The average groundwater level gradient was 0.003205. Given the sum of values above, the average horizontal groundwater velocity for the upper sand interval in Zone H is 0.0091 feet/day or 3.32 feet/year. Table 5.1.4 lists the approximate travel time for groundwater flow from each AOC or SWMU to the Cooper River or Shipyard Creek, depending on direction of groundwater flow, local groundwater gradient, and hydraulic conductivities. Groundwater flow direction within Zone H in the upper sand interval (see Section 3.5, Figure 3.6) is generally from the center of the southern portion of the base toward the south/southwest to Shipyard Creek and toward the north/northeast to the Cooper River. Groundwater levels in Zone H are typically within 6 feet of the surface.

The average CEC for Zone H is 23 milliequivalents per liter (meq/L). The upper interval average is 17 meq/L and the lower interval average is 28 meq/L. CEC ranged from 3.9 to 57 meq/L for both intervals. The average value for pH in Zone H physical parameter samples was 7.87. Upper interval pH average was 8.09 and the lower interval was 7.60. The total range of pH values for soil physical parameter samples collected in Zone H was 7.21-8.56. These soil conditions indicate limited mobility for inorganics advection, diffusion, and dispersion.

The average TOC concentration for Zone H samples was 21,160 mg/kg. The upper interval averaged 18,600 mg/kg and the lower interval averaged 24,288 mg/kg. These data reflect the related trend in grain size distribution where clay content was 17% in the upper interval (TOC — 18,600 mg/kg) and 26% in the lower interval (TOC — 24,288 mg/kg). TOC measurements indicate an organic content which will inhibit the movement of contaminants, particularly those with high K_{oc} values, due to increased soil adsorption.

Table 5.1.1
Chemical and Physical Properties

Chemical Property	Critical Value	High (>)	Low (<)
Vapor Pressure (VP)	10^{-3} mm Mercury (Hg)	Volatile	Nonvolatile
Density[a] (D)	0.75 to 1.25 g/cm^3	Sinks/falls	Floats/rises
Solubility[a] (So)	0 to 100 milligrams per liter (mg/L)	Leaches from soil, mobile in water; does not readily volatilize from water	Adsorbs to soil, immobile in water; volatilizes from water
Henry's law constant (HL)	5×10^{-3} to 5×10^{-6} atm-m^3/mole	High volatilization from water	Low volatilization from water
Half-life ($T_{1/2}$)	biologically dependent	Does not degrade readily	Degrades readily
Log Octonal/Water Partitioning Coefficient[a] (K_{ow})	10 to 10,000 L_{oct}/L_{water}	Remains in soil	Moves and diffuses in water
Organic Carbon/Water Partioning Coefficient[a] (K_{oc})	10 to 10,000 kg_{oc}/L_{water}	Remains in soil	Moves and diffuses in water
Molecular Weight (MW)	400 g/mole	Parts of the above may hold true; more detailed evaluation necessary	All of the above hold true

Note:
a = Determinations for the Critical Ranges were based on literature review and professional judgment.

Table 5.1.2
Zone H
Summary of Physical Parameter Data for Soil

	Sand (%)	Silt (%)	Clay (%)	CEC[a,b] (meq/l)	Moisture (%)	pH	TOC[a,b] (mg/kg)
Total Soil Sample Average	58	22	21	23	23	7.60	21,160
Upper Interval Average	65	19	17	17	15	8.09	18,600
Lower Interval Average	49	25	26	28	32	7.87	24,288
Total Range	3-93	3-54	4-50	3.9-57	4.22-52.7	7.21-8.56	1,800-110,000
Upper Interval Range	3-85	6-52	6-50	4.1-48	4.22-25.1	7.81-8.56	3,000-110,000
Lower Interval Range	4-93	3-54	4-50	3.9-57	11.6-52.7	7.21-8.42	1,800-41,000

Notes:
[a] = Averages were computed using one-half the detection limit for nondetect.
[b] = Ranges are for detections only.

Table 5.1.3
Zone H
Physical Parameter Data from Shelby Tube Samples

Sample Location (Monitoring Well ID)	Sample Depth (feet bgs)	Visual USCS[e] Classification[a]	Porosity (%)	Hydraulic Conductivity (cm/sec)
NBCH00902D	55[c]	MH	62.1	4.927×10^{-7}
NBCHGDH001	10[d]	CH	71.0	1.171×10^{-7}
NBCH660002	10[d]	MH	58.8	2.791×10^{-6}
NBCH00907D	73[c]	MH	47.7	2.928×10^{-6}
NBCHGDH001	15[d]	CL	66.8	1.184×10^{-7}
NBCH178002	10[d]	MH	53.9	3.273×10^{-6}
NBCH009013	14[d]	OH	74.2	9.392×10^{-6}
NBCH009014	13.5[d]	CL	50.1	5.514×10^{-7}
NBCH009015	13[d]	SC	45.4	3.374×10^{-6}
NBCH121001	10[d]	OH	78.4	3.946×10^{-7}
NBCHGDH05D	63[c]	MH	50.2	8.047×10^{-7}
NBCHGDH07D	45[c]	MH	52.4	1.159×10^{-6}
NBCHGDH11D	58[c]	MH	56.5	5.644×10^{-7}
NBCH017004	10[b]	SM-SP	31.9	1.9×10^{-3}
NBCH653002	10[b]	SM-SP	41.2	2.7×10^{-4}
NBCH662002	10[b]	SM-SP	34.6	2.4×10^{-3}
NBCHGDH011	10[b]	SM-SP	40.9	1.8×10^{-4}
	Totals	Upper Sand	37	1.2×10^{-3}
		Ashley Formation	54	1.2×10^{-6}

Notes:

[a] MH Inorganic silt, fine, sandy or silty soil.
CH Inorganic clay of high plasticity, fat clay.
CL Inorganic clay of low to medium plasticity, gravelly clay, sandy clay, silty clay, lean clay.
SC Clayey sand, sand-clay mixtures.
OH Organic clay of medium to high plasticity, organic silts.
SM Silty sand, sand-silt mixtures.
SP Poorly graded sand, gravelly sand, little or no fines.

[b] Upper Sand Interval
[c] Ashley Formation
[d] Marsh Clay
[e] Unified Soil Classification System

Table 5.1.4
Groundwater Travel Times from Zone H AOCs/SWMUs to Surface Water Body[a]
NAVBASE

Site/Point of Origin	Hydraulic Conductivitiy (K) (ft/day)	Gradient (I)	Porosity (n)	Velocity (V) (ft/yr)	Travel Time to Nearest Surface Water Body (years)
013 NBCH013005	2.53	0.00519	0.37	12.95	44 Cooper River
014 NBCH014002	1.445	0.00318	0.37	4.533	378 Cooper River
015 015SB007	1.445	0.00320	0.37	4.563	322 Cooper River
017 NBCH017002	1.422	0.00509	0.37	7.139	161 Cooper River
019 019SB014	0.424	0.00929	0.37	3.887	116 Shipyard Creek
020 NBCH009007	0.424	0.00607	0.37	2.540	75 Shipyard Creek
121 121SB003	0.424	0.00935	0.37	3.909	71 Shipyard Creek
159 159SB013	1.519	0.00575	0.37	8.618	85 Shipyard Creek
178 NBCH178001	0.756	0.00755	0.37	5.632	107 Cooper River
649-650 649SB001	0.424	0.00340	0.37	1.424	1074 Cooper River
653 NBCH653001	0.631	0.00598	0.37	3.723	171 Cooper River

Table 5.1.4
Groundwater Travel Times from Zone H AOCs/SWMUs to Surface Water Body[a]
NAVBASE

Site/Point of Origin	Hydraulic Conductivitiy (K) (ft/day)	Gradient (I)	Porosity (n)	Velocity (V) (ft/yr)	Travel Time to Nearest Surface Water Body (years)
654 654SB002	0.252	0.01	0.37	2.486	105 Shipyard Creek
655 NBCH655002	0.216	0.00343	0.37	0.73	2395 Shipyard Creek
656 NBCH656001	1.368	0.00310	0.37	4.183	530 Cooper River
659 659SB001	1.98	0.00611	0.37	11.936	58 Cooper River
660 NBCH660001	1.98	0.00633	0.37	12.363	49 Cooper River
662 NBCH662001	3.767	0.00235	0.37	8.734	200 Cooper River
663-136 NBCH178001	0.756 (SWMU 178)	0.00755	0.37	5.632	107 Cooper River
665 665SB001	0.308	0.00705	0.37	2.143	252 Cooper River
666 NBCH666001	0.563	0.00185	0.37	1.026	1000 Cooper River
667-138 667SB011	0.441	0.00254	0.37	1.106	1353 Cooper River
670 670SB011	1.445	0.00319	0.37	4.548	310 Cooper River

Table 5.1.4
Groundwater Travel Times from Zone H AOCs/SWMUs to Surface Water Body[a]
NAVBASE

Site/Point of Origin	Hydraulic Conductivitiy (K) (ft/day)	Gradient (I)	Porosity (n)	Velocity (V) (ft/yr)	Travel Time to Nearest Surface Water Body (years)
684 684SB003	1.445	0.00331	0.37	4.719	230 Cooper River
690	Must be calculated separately for each sample location, due to the distribution of locations versus proximity to Shipyard Creek.				

Notes:
[a] = Direction and destination of groundwater flow path based on Figure 3.6.
K = Hydraulic Conductivity (values derived from slug test data from specific well listed or number of closest wells).
I = Gradient (groundwater elevation in well divided by distance to nearest surface water body as measured on map).
n = Porosity (mean of four Shelby Tube samples)
V = Mean Calculated Groundwater Flow Velocity

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5.2 Fate and Transport Approach for Zone H

Fate and transport discussion for each SWMU/AOC begins by describing site characteristics that have the potential to promote or inhibit constituent migration. As presented in Section 5, four potential routes of constituent migration have been identified for Zone H. Each SWMU and AOC was evaluated as to site conditions that affect these migration pathways. In some cases, it is logical to evaluate fate and transport for a combination of SWMUs/AOCs based on their proximity.

An individual constituent's ability to migrate is evaluated based on four cross-media transfer mechanisms: soil to groundwater, groundwater to surface water, surface soil to air, and/or surface soil to sediment. Cases have been made for each of these transfer mechanisms based on empirical data available for each environmental medium sampled. For example, if a constituent is found in soil as well as in groundwater, it is reasonable to conclude that surface soil constituents may be leaching to the groundwater. The chemical and physical properties of the constituent and the media were evaluated, where necessary, in support of such conclusions. Table 5.2.1 presents the constituent specific chemical and physical properties and risk-based screening concentrations or grid-based background UTLs used to evaluate fate and transport for Zone H.

The following discussions describe the methods used to evaluate the potential migration of constituents identified at each SWMU/AOC. In some cases, specific migration pathways do not exist for a site. When a particular pathway was not identified for a site, no screening or formal assessment was performed. Fate and transport were not evaluated for essential nutrients (calcium, iron, magnesium, potassium, and sodium) or chlorides, which are found in abundance in shallow coastal/estuarine aquifers.

5.2.1 Soil-to-Groundwater Cross-Media Transport

To evaluate the potential for soil to groundwater migration of constituents, a phased screening approach was used to focus on chemicals with the greatest potential for impacting the shallow water-bearing zone. The screening process may be summarized as follows:

- Qualitative — The CPSS lists (excluding essential nutrients and chloride) for soil (all depths) and shallow groundwater were compared to determine which chemicals were present in both media.

Due to the nature and age of most SWMU/AOC operations, it was assumed that any impacts associated with compounds with the potential to migrate from soil would be currently manifested in the shallow aquifer. This assumption is also appropriate in light of the thin, relatively permeable soil layer across Zone H. In addition, the number and placement of monitoring wells in the vicinity of SWMUs/AOCs in Zone H was considered adequate to detect the presence of groundwater contamination. As a result, the qualitative comparison was used to identify those chemicals with reported concentrations in both media.

- Quantitative — Maximum soil results for each SWMU/AOC (or group thereof) were compared to the greater of (1) the leachability-based soil to groundwater screening levels, assuming a dilution attenuation factor of 10, as presented in the USEPA Region III *Risk-Based Concentration (RBC) Table*, March 1995 (or USEPA Soil Screening Guidance assuming a dilution/attenuation factor of 10), or (2) grid-based background UTL concentrations for soil in Zone H. Maximum groundwater analytical results for each SWMU/AOC (or group thereof) were compared to the greater of the tap water RBCs or grid-based background UTLs for the shallow aquifer in Zone H.

The purpose of the quantitative assessment was to develop a comprehensive list of chemicals under consideration for formal fate and transport evaluation. To that end, a Tier I approach, using generic soil screening levels (SSLs), was employed as a conservative screening tool. Default soil characteristics used to estimate generic SSLs are similar to the soil characteristics found in Zone H. Two parameters that would see significant adjustment based on site-specific analysis is the dilution attenuation factor (DAF) and the fraction organic carbon. The estimated SSL increases with higher fraction organic carbon and DAF. The default soil fraction organic carbon is 0.2% versus close to 2% reported for Zone H soil on average. The default DAF (10) assumes an evenly contaminated 30 acre source that extends downward through the unsaturated zone. Many of the areas of contamination identified at Zone H are significantly less than 30-acres (most are less than ½ acre) and do not extend far into the subsurface. Sources that are less than 30-acres with a significant portion of uncontaminated unsaturated zone would justify higher DAFs. Chemicals identified during quantitative Tier I screening were carried to the detailed assessment which employs site-specific Tier 2 and 3 analyses. It was assumed that if soil concentrations do not exceed leachability-based screening levels or background, no significant migration potential exists. In addition, if current groundwater concentrations do not exceed risk-based screening values, the conclusion was made that current soil/groundwater conditions are sufficiently protective of human health relative to potential groundwater exposure pathways.

- Detailed Assessment — After completing the qualitative and quantitative screening processes, detailed analyses were performed to delineate the areal extent of soil impacts potentially affecting groundwater.

The outcome of the detailed assessment was used to determine the significance of soil impacts relative to the shallow aquifer. In some instances, isolated areas of soil contamination above leachability-based levels may have the potential for localized shallow groundwater impacts but not be of a magnitude which would pose a long-term or widespread threat to the aquifer. The detailed assessment was used to identify these cases, as well as to draw conclusions as to what areas of soil contamination may require supplemental investigation and/or modeling applications during the CMS as part of the remedial alternatives development process.

5.2.2 Soil-to-Air Cross-Media Transport

To evaluate the potential for soil to air migration of volatile contaminants, a screening approach was used to focus on chemicals that have the greatest potential to volatilize in sufficient quantities to create a human health threat in ambient air. The screening process may be summarized as follows:

- Quantitative — The maximum concentrations of volatile CPSSs detected in surface soil at each SWMU/AOC were compared to soil-to-air screening levels as presented in the USEPA Region III RBC Table, March 1995.

No qualitative screening was performed because ambient air monitoring was not an integral part of the RFIs for each site. The Focused Field Investigation (FFI) involved collecting numerous samples from building interiors and subslab voids in Zone H. As part of the FFI BRA, correlative evaluations were performed between air sampling results and data produced during the RFI.

The quantitative assessment's purpose was to further refine the list of chemicals being considered for formal fate and transport evaluation. It was assumed that if soil concentrations do not exceed soil-to-air volatilization screening levels, no significant migration potential exists and current soil conditions are protective of human health relative to potential inhalation exposure pathways.

- Detailed Assessment — After completing the quantitative screening process, detailed analyses were performed to delineate the areal extent of surface soil impacts potentially affecting ambient air.

The outcome of the detailed assessments was used to determine the significance of soil impacts relative to ambient air. In some instances, isolated areas of soil contamination above soil-to-air volatilization-based levels may have the potential for localized ambient air impacts but not be of a magnitude to pose a long-term or widespread threat through inhalation pathways. The detailed assessment was used to identify these cases as well as to make conclusions as to what areas of soil contamination may require supplemental investigation and/or modeling applications during the CMS as part of the remedial alternatives development process.

5.2.3 Groundwater-to-Surface Water Cross-Media Transport

The principal focus of this evaluation was determining whether constituents identified in groundwater have the potential to extend their impacts or discharge to surface water. The screening process may be summarized as follows:

- Qualitative — The CPSS list for shallow groundwater was examined to identify the following: all constituents detected in both groundwater and surface water; and all constituents detected in groundwater that, if groundwater transfer to surface water should prove significant, may have an impact on human or ecological receptors.

Many SWMUs/AOCs investigated at NAVBASE have no surface water onsite or nearby. As a result, qualitative comparisons of shallow groundwater and surface water data are supported for only a few SWMUs/AOCs. Potential impact on ecological receptors was qualitatively evaluated for sites with no surface water by identifying contaminants detected in shallow groundwater that also appear on USEPA's list of Water Quality Criteria (WQC) protective of aquatic organisms.

- Quantitative — Chemicals present in groundwater and/or surface water were compared to appropriate screening values. For human health evaluation, maximum shallow groundwater results for each SWMU/AOC (or group thereof) were compared to the greater of (1) the tap water risked-based screening levels presented in the USEPA Region III RBC Table, March 1995, and (2) grid-based background UTLs for the shallow aquifer in Zone H. Maximum surface water analytical results for each SWMU/AOC were compared to SCDHEC and/or USEPA Ambient Water Quality Criteria (AWQC) to address potential ecological concerns.

The quantitative assessment was conducted to identify chemicals detected in groundwater with the potential to disperse within the aquifer, thereby increasing the areal extent of groundwater concentrations that exceed human health based standards, or impact surface water via groundwater migration and discharge. It was assumed that if groundwater concentrations do not exceed tap water risk-based screening levels, grid-based background UTLs or AWQC, no significant threat relative to migration potential exists. This assessment does not consider potential dilution/attenuation factors affecting transport between the affected well and the surface water discharge point, or the dilution capacity of the receiving water body. Omitting these factors from the quantitative screening ensures that a conservative list of potential groundwater to surface water concerns is developed.

- Detailed Assessment — After completing the qualitative and quantitative screening processes, detailed analyses were performed to delineate the areal extent of groundwater and/or surface water impacts that may adversely affect human or ecological receptors.

The outcome of the detailed assessments was used to determine the significance of shallow groundwater and surface water impacts. In addition, in areas where no surface water data were collected as part of the Zone H RFI, a preliminary determination regarding the potential for significant surface water impacts was made. These assessments were based on data collected from wells near surface water bodies, and in some instances, incorporated conservative estimates of the dilutional influences of the receiving stream or water body, plus travel time analysis, which assists in predicting mass flux to the receiving stream. The results of the Zone J RFI will be used to confirm or refute preliminary conclusions. The detailed assessment was used to identify these cases as well as to render conclusions regarding what areas of shallow groundwater and/or surface water contamination may require supplemental investigation and/or modeling applications during the CMS as part of the remedial alternatives development process.

5.2.4 Surface Soil-to-Sediment Cross-Media Transport

To evaluate the potential for surface soil-to-sediment erosional migration, a phased screening approach was used to identify chemicals with the potential to form contaminated sediments following surface soil erosion. The screening process may be summarized as follows:

- Qualitative — The CPSS lists (excluding essential nutrients and chloride) for surface soil and sediment were compared to determine which chemicals were present in both media.

The most influential process by which sediments are formed involves the erosion of surface soil which eventually collects in depositional areas. Site topography was used to determine areas with erosional potential and expected depositional areas. Qualitative screening was used to identify constituents common to both media. Because erosional/depositional processes within Zone H are expected to be localized based on limited relief and soil conditions, screening focused on these localized units. Sediment results were compared to data for proximate surface soil representing the most likely point of sediment contaminant origination.

- Semiquantitative — For those constituents present in both media, the maximum concentration in surface soil was compared to the maximum concentration in related sediment.

The purpose of the semiquantitative assessment was to provide additional evidence supporting this migration pathway. Any impacts to ecological receptors with regard to contaminated sediments have been addressed for Zone H in Section 7 or will be addressed in the Zone J RFI, depending on their specific location.

Table 5.2.1
Fate and Transport Properties and Screening Levels for
Constituents Detected in Soil and Groundwater
NAVBASE-Charleston, Zone H

Parameter	Vapor Pressure (mm Hg)	Density (g/cm3)	Solubilit (mg/L)	Henry's Law Constant (atm-m3/ mole)	Organic Carbon Water Part. Coeff. (L/kg)	Salt Water Chronic WQC ! (ug/L)	Tap Water RBC or UTL *	Water Units		Ground Water Protection SSL or UTL **	Soil Units	
Acenaphthene	1.6E-03	1.0E+00	3.5E+00	1.70E-04	1.78E+01	NDA	220	UG/L	a	20000	UG/KG	a,b
Acenaphthylene	2.9E-02	9.0E-01	3.9E+00	2.00E-04	3.97E+01	NDA	220	UG/L	c	20000	UG/KG	c
Acetone	2.7E+02	7.9E-01	1.0E+06	3.97E-05	3.70E-01	NDA	370	UG/L	a	800	UG/KG	a,b
Acetonitrile	8.8E+01	7.9E-01	NDA	2.93E-05	4.80E-01	NDA	22	UG/L	a	70	UG/KG	n
Acrylonitrile	1.0E+02	8.0E-01	7.9E+04	1.10E-04	7.40E-02	NDA	0.12	UG/L		0.04	UG/KG	n
Aldrin	6.0E-06	1.7E+00	2.7E-02	2.67E-05	4.07E+02	NDA	0.004	UG/L		5	UG/KG	
Aluminum	NA	NA	NA	NA	NA	NDA	3700	UG/L	a	46180	MG/KG	d
Ammonia	NDA	NDA	NDA	NDA	NDA	NDA	34	MG/L		NDA		
Anthracene	2.0E-04	1.3E+00	4.5E-02	6.50E-05	1.86E+04	NDA	1100	UG/L	a	430000	UG/KG	a,b
Antimony	NA	NA	NA	NA	NA	NDA	1.5	UG/L	a	NDA		
Aroclor-1248	4.9E-04	1.4E+00	5.4E-02	3.50E-03	4.37E+05	0.03	0.0087	UG/L		8200	UG/KG	
Aroclor-1254	7.7E-05	1.5E+00	5.0E-02	2.70E-03	4.31E+05	0.03	0.0087	UG/L		8200	UG/KG	
Aroclor-1260	4.1E-05	1.6E+00	8.0E-02	7.10E-03	8.22E+05	0.03	0.0087	UG/L		8200	UG/KG	
Arsenic	NA	NA	NA	NA	NA	36	27.99	UG/L	d	35.52	MG/KG	d
Azobenzene	NDA	NDA	NDA	NDA	NDA	NDA	0.61	UG/L		NDA		
beta-BHC	2.8E-07	1.9E+00	2.4E-01	2.30E-07	2.48E+03	NDA	0.037	UG/L		2	UG/KG	
alpha-BHC	2.5E-05	1.9E+00	1.6E+00	5.30E-06	1.82E+03	NDA	0.011	UG/L		0.4	UG/KG	
delta-BHC	1.7E-05	1.9E+00	3.1E-01	2.50E-07	1.50E+03	NDA	0.052	UG/L	e	6	UG/KG	e
gamma-BHC (Lindane)	6.7E-05	1.6E+00	7.5E+00	3.25E-06	1.21E+03	NDA	0.052	UG/L		6	UG/KG	
Barium	NA	NA	NA	NA	NA	NDA	323	UG/L	d	43.8	MG/KG	d
Benzene	9.5E+01	8.7E-01	1.8E+03	5.40E-03	5.00E+01	NDA	0.36	UG/L		20	UG/KG	
Benzidine	5.0E-04	1.3E+00	4.0E+02	3.88E-11	3.98E+01	NDA	0.00029	UG/L		0.0011	UG/KG	
Benzo(g,h,i)perylene	1.0E-10	NDA	2.6E-04	1.40E-07	7.76E+06	NDA	150	UG/L	f	98000	UG/KG	f
Benzo(a)pyrene Equivalents	5.6E-09	1.4E+00	3.9E-03	2.40E-06	1.77E+06	NDA	0.0092	UG/L		4000	UG/KG	
Benzoic acid	1.0E+00	1.3E+00	3.4E+03	7.02E-07	1.82E+02	NDA	15000	UG/L	a	28000	UG/KG	a,b
Beryllium	NA	NA	NA	NA	NA	NDA	0.016	UG/L		180	MG/KG	
Bromomethane	1.6E+03	1.7E+00	1.3E+04	2.00E-01	8.32E+01	NDA	0.87	UG/L	a	10	UG/KG	a,b
4-Bromophenyl-phenylether	1.5E-03	1.4E+00	NDA	1.00E-04	8.71E+04	NDA	210	UG/L	a	36600	UG/KG	
2-Butanone (MEK)	7.8E+01	8.1E-01	2.7E+05	4.66E-05	1.23E+00	NDA	190	UG/L	a	570	UG/KG	n
Butylbenzylphthalate	8.6E-06	1.1E+00	2.8E+00	1.30E-06	1.51E+02	NDA	730	UG/L	a	6800	UG/KG	a,b
Cadmium	NA	NA	NA	NA	NA	9.3	1.8	UG/L	a	6	MG/KG	h
Carbon disulfide	3.0E+02	1.3E+00	2.1E+03	1.33E-02	2.95E+02	NDA	2.1	UG/L	a	1400	UG/KG	a,b
alpha-Chlordane	1.0E-05	1.6E+00	5.6E-02	4.80E-05	4.95E+04	0.004	0.052	UG/L		2000	UG/KG	
gamma-Chlordane	1.0E-05	1.6E+00	5.6E-02	4.80E-05	4.95E+04	NDA	0.052	UG/L		2000	UG/KG	
Chlorobenzene	1.0E+01	1.1E+00	4.9E+02	3.93E-03	1.73E+02	NDA	3.9	UG/L	a	60	UG/KG	a,b
Chlorobenzilate	2.2E-06	NDA	1.3E+01	7.24E-08	1.07E+03	NDA	0.25	UG/L		0.6	UG/KG	n
Chloroethane	1.0E+03	9.0E-01	5.7E+03	1.00E-02	3.47E+00	NDA	860	UG/L	a	3300	UG/KG	a,b
bis(2-Chloroethyl)ether	1.2E+00	1.2E+00	1.0E+04	1.30E-05	1.41E+01	NDA	0.0092	UG/L		0.3	UG/KG	
Chloroform	1.6E+02	1.5E+00	8.0E+03	3.23E-03	4.60E+01	NDA	0.15	UG/L		300	UG/KG	
Chloromethane	3.8E+03	9.2E-01	7.3E+03	8.82E-03	2.51E+01	NDA	1.4	UG/L		6.6	UG/KG	
4-Chloro-3-methylphenol	5.0E-02	NDA	3.9E+03	1.78E-06	7.76E+02	NDA	NDA			NDA		
2-Chlorophenol	1.4E+00	1.3E+00	2.8E+04	8.28E-06	3.63E+02	NDA	18	UG/L	a	200	UG/KG	a,b
Chromium	NA	NA	NA	NA	NA	50	18	UG/L	a	85.65	MG/KG	d
Cobalt	NA	NA	NA	NA	NA	NDA	220	UG/L	a	14.88	MG/KG	d
Copper	NA	NA	NA	NA	NA	2.9	140	UG/L	a	31.62	MG/KG	d
Cyanide	NA	NA	NA	NA	NA	1	75	UG/L	a	NDA		
2,4-D	1.1E-02	1.4E+00	6.8E+02	1.37E-10	1.58E+00	NDA	6.1	UG/L	a	1700	UG/KG	h
2,4-DB	NDA	NDA	NDA	NDA	NDA	NDA	29	UG/L	a	1000	UG/KG	r
4,4'-DDD	1.0E-06	1.5E+00	2.0E-02	2.16E-05	4.37E+04	NDA	0.28	UG/L		700	UG/KG	
4,4'-DDE	6.5E-06		4.0E-02	2.34E-05	2.45E+05	NDA	0.2	UG/L		500	UG/KG	
4,4'-DDT	1.9E-07	1.6E+00	5.0E-03	4.89E-05	3.87E+05	0.001	0.2	UG/L		1000	UG/KG	
DCAA	NDA	NDA	NDA	NDA	NDA	NDA	NDA			NDA		
Dibenzofuran	NDA	1.1E+00	1.0E+01	NDA	1.00E+04	NDA	15	UG/L	a	12000	UG/KG	a,b
Dibromochloromethane	7.6E+01	2.5E+00	4.0E+03	9.90E-04	8.32E+01	NDA	NDA			38	UG/KG	p

Table 5.2.1
Fate and Transport Properties and Screening Levels for
Constituents Detected in Soil and Groundwater
NAVBASE-Charleston, Zone H

Parameter	Vapor Pressure (mm Hg)	Density (g/cm3)	Solubilit (mg/L)	Henry's Law Constant (atm-m3/ mole)	Organic Carbon Water Part. Coeff. (L/kg)	Salt Water Chronic WQC ! (ug/L)	Tap Water RBC or UTL *	Water Units		Ground Water Protection SSL or UTL **	Soil Units	
Di-n-butylphthalate	1.0E-05	1.0E+00	1.3E+01	6.30E-05	1.38E+03	NDA	370	UG/L	a	12000	UG/KG	a,b
1,2-Dichlorobenzene	1.0E+00	1.3E+00	1.0E+02	1.90E-03	1.82E+02	NDA	27	UG/L	a	600	UG/KG	h
1,4-Dichlorobenzene	6.0E-01	1.2E+00	7.9E+01	3.10E-03	5.11E+02	NDA	0.44	UG/L		1000	UG/KG	h
1,3-Dichlorobenzene	2.3E+00	1.3E+00	1.2E+02	3.60E-03	1.70E+02	NDA	54	UG/L	a	600	UG/KG	g
1,2-Dichloroethane	6.4E+01	1.3E+00	8.7E+03	9.80E-04	1.41E+01	NDA	0.12	UG/L		10	UG/KG	
1,1-Dichloroethane	1.8E+02	1.2E+00	5.5E+03	5.45E-03	3.40E+01	NDA	81	UG/L	a	1100	UG/KG	
1,2-Dichloroethene (total)	3.0E+02	NDA	3.5E+03	5.00E-03	2.30E-02	NDA	5.5	UG/L	a	300	UG/KG	h,i
1,1-Dichloroethene	5.9E+02	1.2E+00	2.3E+03	1.80E-02	6.50E+01	NDA	0.044	UG/L		30	UG/KG	h
2,4-Dichlorophenol	8.9E-02	1.4E+00	4.5E+03	6.66E-06	8.71E+02	NDA	11	UG/L	a	50	UG/KG	a,b
Dieldrin	1.8E-07	1.8E+00	2.0E-01	2.00E-05	1.34E+04	0.0019	0.0042	UG/L		1	UG/KG	
Diethylphthalate	2.0E-03	1.1E+00	9.0E+02	8.46E-07	6.92E+01	NDA	2900	UG/L	a	11000	UG/KG	a,b
7,12-Dimethybenz(a)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA			700	UG/KG	q
2,4-Dimethylphenol	9.8E-02	9.7E-01	6.2E+03	6.55E-06	1.18E+02	NDA	73	UG/L	a	300	UG/KG	a,b
2,4-Dinitrotoluene	5.1E-03	1.4E+00	2.7E+02	8.67E-07	6.17E+01	NDA	7.3	UG/L	a	20	UG/KG	a,b
Di-n-octylphthalate	1.4E-03	9.8E-01	3.0E+00	1.41E-12	9.77E+08	NDA	73	UG/L	a	1E+08	UG/KG	a,b
Dioxin (TCDD TEQ)	NDA	NDA	NDA	NDA	3.30E+06	NDA	0.5	PG/L		280	PG/G	s
Diphenylamine	NDA	NDA	NDA	NDA	NDA	NDA	91	UG/L	a	NDA		
Endosulfan I	1.0E-05	1.7E+00	5.3E-01	1.01E-04	2.04E+03	0.0087	22	UG/L	j	400	UG/KG	a,b,j
Endosulfan II	1.0E-05	1.7E+00	2.8E-01	1.91E-05	2.34E+03	0.0087	22	UG/L	j	400	UG/KG	a,b,j
Endosulfan sulfate	NDA	NDA	1.2E-01	NDA	2.34E+03	NDA	22	UG/L	j	400	UG/KG	a,b,j
Endrin	7.0E-07	1.7E+00	2.3E-01	5.00E-07	8.32E+03	0.0023	1.1	UG/L	a	400	UG/KG	h
Endrin aldehyde	2.0E-07	NDA	2.6E-01	3.86E-07	2.69E+04	NDA	1.1	UG/L	k	400	UG/KG	k
Ethylbenzene	7.1E+00	8.7E-01	1.5E+02	6.60E-03	1.87E+02	NDA	130	UG/L	a	5000	UG/KG	h
bis(2-Ethylhexyl)phthalate (BEHP	2.0E-07	9.9E-01	3.0E-01	1.10E-05	1.00E+05	NDA	4.8	UG/L	a	11000	UG/KG	a,b
Fluoranthene	5.0E-06	1.3E+00	2.4E-01	1.69E-02	4.17E+04	NDA	150	UG/L	a	98000	UG/KG	a,b
Fluorene	7.0E-03	1.2E+00	1.7E+00	2.10E-04	5.01E+03	NDA	150	UG/L	a	16000	UG/KG	a,b
Heptachlor	3.0E-04	1.7E+00	1.8E-01	2.30E-03	2.69E+04	0.0036	0.0023	UG/L		60	UG/KG	h
Heptachlor epoxide	2.6E-06	NDA	3.5E-01	3.20E-05	2.09E+04	0.0036	0.0012	UG/L		30	UG/KG	h
Hexachlorobenzene	1.1E-05	1.6E+00	6.0E-03	1.70E-03	3.89E+03	NDA	0.0066	UG/L		800	UG/KG	h
Hexachlorobutadiene	1.5E-01	1.6E+00	3.2E+00	1.03E-02	4.68E+03	NDA	0.14	UG/L		100	UG/KG	h
Hexachlorocyclopentadiene	8.1E-02	1.7E+00	1.1E+00	1.60E-02	4.27E+03	NDA	0.015	UG/L	a	10000	UG/KG	h
Hexachloroethane	2.1E-01	NDA	5.0E+01	2.80E-03	3.10E-01	NDA	0.61	UG/L	a	200	UG/KG	
Isodrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA			NDA		
Kepone	3.0E-07	NDA	7.6E+00	2.50E-08	2.45E+03	NDA	0.0037	UG/L		NDA		
Lead	NA	NA	NA	NA	NA	8.5	15	UG/L	o	118	MG/KG	d
Manganese	NA	NA	NA	NA	NA	NDA	3391	UG/L	d	1412	MG/KG	d
Mercury	NA	NA	NA	NA	NA	0.025	1.1	UG/L	a	3	MG/KG	h
Methoxychlor	1.4E-06	1.4E+00	4.0E-02	1.58E-05	7.94E+04	NDA	18	UG/L	a	62000	UG/KG	h
Methyl parathion	9.6E-06	NDA	5.0E+01	1.00E-07	6.34E+01	NDA	0.91	UG/L	a	4.1	UG/KG	a,b
4-Methyl-2-Pentanone (MIBK)	1.5E+01	8.0E-01	1.7E+04	1.49E-05	6.17E+00	NDA	290	UG/L	a	910	UG/KG	n
Methylene chloride	3.5E+02	1.3E+00	2.0E+04	2.00E-03	2.30E+01	NDA	4.1	UG/L		10	UG/KG	
2-Methylnaphthalene	NDA	1.0E+00	2.5E+01	NDA	8.51E+03	NDA	150	UG/L	l	3000	UG/KG	l
2-Methylphenol	2.4E-01	1.0E+00	2.5E+04	1.23E-06	2.19E+01	NDA	180	UG/L	a	600	UG/KG	a,b
4-Methylphenol	4.0E-02	1.0E+00	2.3E+04	7.92E-07	4.90E+01	NDA	18	UG/L	a	600	UG/KG	m
Naphthalene	5.4E-02	1.1E+00	3.0E+01	4.60E-04	7.92E+02	NDA	150	UG/L	a	3000	UG/KG	a,b
Nickel	NA	NA	NA	NA	NA	8.3	73	UG/L	a	33.38	MG/KG	d
4-Nitrophenol	1.0E-04	1.5E+00	1.3E+04	3.00E-05	2.14E+02	NDA	230	UG/L	a	1670	UG/KG	n
N-Nitroso-di-n-propylamine	4.0E-01	9.2E-01	9.9E+03	6.92E-06	1.02E+01	NDA	0.0096	UG/L		0.02	UG/KG	
N-Nitrosodiphenylamine	NDA	NDA	NDA	NDA	NDA	NDA	14	UG/L		200	UG/KG	
Parathion	9.7E-06	NDA	6.5E+00	5.65E-07	6.61E+02	NDA	22	UG/L	a	390	UG/KG	a,b
Pentachlorophenol	1.1E-04	2.0E+00	2.0E+01	2.10E-06	4.09E+02	7.9	0.56	UG/L		200	UG/KG	
Phenanthrene	6.8E-04	1.2E+00	1.0E+00	3.90E-05	2.29E+04	NDA	150	UG/L	f	98000	UG/KG	f
Phenol	2.0E-01	1.1E+00	8.2E+04	2.70E-07	2.69E+01	NDA	2200	UG/L	a	4900	UG/KG	a,b
Pyrene	2.5E-06	1.3E+00	1.4E-01	1.09E-05	6.46E+04	NDA	110	UG/L	a	140000	UG/KG	a,b

Table 5.2.1
Fate and Transport Properties and Screening Levels for
Constituents Detected in Soil and Groundwater
NAVBASE-Charleston, Zone H

Parameter	Vapor Pressure (mm Hg)	Density (g/cm3)	Solubilit (mg/L)	Henry's Law Constant (atm-m3/ mole)	Organic Carbon Water Part. Coeff. (L/kg)	Salt Water Chronic WQC ! (ug/L)	Tap Water RBC or UTL *	Water Units		Ground Water Protection SSL or UTL **	Soil Units	
Selenium	NA	NA	NA	NA	NA	71	18	UG/L	a	3	MG/KG	h
Silver	NA	NA	NA	NA	NA	NDA	18	UG/L	a	NDA		
2,4,5-T	7.5E-07	1.4E+00	2.8E+02	8.68E-08	2.04E+02	NDA	37	UG/L	a	260	UG/KG	n
2,4,5-TP (Silvex)	5.2E-06	NDA	1.4E+02	1.31E-07	2.57E+03	NDA	29	UG/L	a	1580	UG/KG	n
Total Petroleum Hydrocarbons (IR	NDA	NDA	NDA	NDA	NDA	NDA	NDA			NDA		
Tetrachloroethene	1.4E+01	1.6E+00	1.5E+02	1.53E-02	2.64E+02	NDA	1.1	UG/L		40	UG/KG	
Tetrahydrofuran	1.6E+02	8.9E-01	NDA	9.63E-03	1.95E+00	NDA	NDA			NDA		
Thallium	NA	NA	NA	NA	NA	NDA	7.66	UG/L	d	1.3	MG/KG	d
Tin	NA	NA	NA	NA	NA	NDA	2200	UG/L	a	NDA		
Toluene	2.2E+01	8.7E-01	5.2E+02	6.70E-03	1.29E+02	NDA	75	UG/L	a	5000	UG/KG	h
Toxaphene	3.3E-05	1.6E+00	7.4E-01	6.30E-02	1.51E+03	0.0002	0.061	UG/L		40	UG/KG	h
1,2,4-Trichlorobenzene	4.0E-01	1.5E+00	3.0E+01	2.32E-03	1.56E+03	NDA	19	UG/L	a	2000	UG/KG	h
1,1,1-Trichloroethane	1.0E+02	1.3E+00	1.6E+03	1.62E-02	1.28E+02	NDA	130	UG/L	a	900	UG/KG	h
Trichloroethene	5.8E+01	1.5E+00	1.1E+03	9.10E-03	8.70E+01	NDA	1.6	UG/L		20	UG/KG	h
Trichlorofluoromethane	6.9E+02	1.5E+00	1.1E+03	1.10E-01	1.59E+02	NDA	130	UG/L	a	1300	UG/KG	a,b
2,4,5-Trichlorophenol	NDA	1.7E+00	NDA	NDA	NDA	NDA	370	UG/L	a	12000	UG/KG	a,b
2,4,6-Trichlorophenol	1.7E-02	1.5E+00	8.0E+02	9.07E-08	1.07E+03	NDA	6.1	UG/L		50	UG/KG	
1,2,3-Trichloropropane	3.1E+00	1.4E+00	1.8E+03	3.44E-04	7.24E+01	NDA	0.0015	UG/L		0.006	UG/KG	
Vanadium	NA	NA	NA	NA	NA	NDA	26	UG/L	a	131.6	MG/KG	d
Vinyl chloride	2.6E+03	9.1E-01	1.1E+03	1.22E+00	1.10E+01	NDA	0.019	UG/L		10	UG/KG	h
Xylene (total)	8.7E+00	8.8E-01	2.0E+02	7.10E-03	2.34E+02	NDA	1200	UG/L	a	74000	UG/KG	h
Zinc	NA	NA	NA	NA	NA	86	1100	UG/L	a	4200	MG/KG	

* - Ground water screening concentration which is the greater of:
1. Tap water risk-based concentration as presented in EPA Region III tables (1/31/95)
2. Background upper tolerance limit for shallow groundwater; NAVBASE Charleston - Zone H

** - Soil screening concentration which is the greater of:
1. Soil screening levels which governs soil to water transfer as presented in EPA Region III risk-based concentration tables (1/31/95)
2. Background upper tolerance limit for surface or subsurface soil; NAVBASE Charleston - Zone H
(Risk based screening concentrations assume a target risk of 1E-06, a target hazard index of 0.1, and a dilution attenuation factor of 10)

! - Salt Water Chronic Water Quality Criteria as provided in EPA (1993) Quality Criteria for Water

NA - Not applicable
NDA - No data available
a - based on target hazard index of 0.1
b - target soil leachate concentration based on the tap water RBC
c - acenaphtene used as a surrogate
d - background upper tolerance limit
e - gamma-BHC used as a surrogate
f - fluoranthene used as a surrogate
g - 1,2-dichlorobenzene used as a surrogate
h - target leachate soil concentration based on a MCL
i - value for trans - 1,2-dichloroethene
j - endosulfan used as a surrogate
k - endrin used as a surrogate
l- naphthalene used as a surrogate
m - 2-methylphenol used as a surrogate
n - Calculated using Soil Screening Guidance (EPA 12/94) using contaminant specific values
o - Treatment technique action level for water
p - based on the MCL for total trihalomethanes of 0.08 mg/L
q - benzo(a)anthracene used as a surrogate
r - estimated to be greater than 1000 ug/kg based on structural similarities to 2,4-D
s - Dioxin (TCDD TEQ) soil screening value based on the tap water RBC and site specific soil parameters

5.3 SWMU 9 (Includes SWMUs 19, 20, and 121, and AOCs 649, 650, 651, and 654)

SWMU 9 is a closed landfill at the southeast end of NAVBASE. Shipyard Creek forms the southwest boundary of SWMU 9 and submerges a portion of the site during high tide. The former landfill portion of SWMU 9 is open with few paved or capped areas to prevent rainwater infiltration. The landfill cap, where present, is typically sand with a low percentage of clay. Vegetation covers most of the SWMU 9 area except SWMUs 19 and 20, and the public works corral area. Environmental media sampled as part of SWMU 9 include shallow and deep groundwater, sediment, and surface water.

SWMUs 19, 20, and 121, and AOCs 649, 650, 651, and 654 are in the SWMU 9 boundary. SWMU 19 is a flat, fenced, nonvegetated area that serves as temporary storage for solid waste before transport offsite. SWMU 20, previously a waste disposal/storage area, has minimal vegetative cover with evidence of buried debris apparent. SWMU 121 comprises Building 801 (used to collect, sort, and store recyclable material) and an SAA. AOCs 649, 650, and 651, formerly storage areas for ship repair, painting, and sandblasting supplies, are situated in an open, grassy, low-lying area. AOC 654, formerly a septic tank and leach field for Building 661, is located in the southeast corner of SWMU 9. Surface and subsurface soil were sampled in these SWMUs/AOCs except for AOC 651. The evaluation of constituent transfer from soil to groundwater was based on a comparison of the soil data from these SWMUs/AOCs and the shallow groundwater data from overall SWMU 9.

Potential migration pathways for SWMU 9 include constituents leaching from soil to groundwater, groundwater constituents migrating to surface water, emission of volatile constituents from surface soil to air, and surface soil erosion of sorbed constituents, forming sediments. The 2- to 3-foot cover of primarily sandy dredge spoil material and a relatively uniform vegetative cover should prevent direct contact with soil constituents and should also limit the significance of the surface water erosional transport mechanism. In areas where the cover material has been removed or was never emplaced, the likelihood of constituent movement by the erosional mechanism increases. Based on local surface topography and associated surface water drainage patterns, the most likely receptors for constituents originating in the SWMU 9 area are Shipyard Creek and its associated wetlands.

5.3.1 SWMU 9 — Soil-to-Groundwater Cross-Media Transport

Table 5.3.1 compares the maximum detected concentration of constituents in soil for SWMUs 19, 20, and 121 and AOCs 649, 650 and 654 to the greater of the risk-based soil screening level considered protective of groundwater or background UTL. Additional notations are made for those contaminants detected in shallow groundwater and those which exceeded the tap water RBCs. Nine constituents are highlighted as posing a potential soil to groundwater migration concern as determined by soil concentrations in excess of groundwater protection SSLs or background UTLs and groundwater concentrations above the tap water RBCs. These include four VOCs (benzene, chlorobenzene, methylene chloride, and trichloroethene), and five inorganic chemicals (barium, chromium, copper, lead, and vanadium). Generally, VOCs have a low affinity for soil particles and high water solubilities, which facilitates their movement to groundwater through the advective and dispersive transport mechanisms. Based on the physical and chemical parameters of the soil surrounding SWMU 9, the high amount of dissolved salts in the groundwater, and the neutral to high pH, inorganics will tend to precipitate and sorb to soil particles rather than dissolve and travel in groundwater.

SWMU 19 constituents that exhibit the potential for soil-to-groundwater transport, based on comparison of soil concentrations to the groundwater protection soil screening criteria or background UTLs, are inorganics (barium, cobalt, copper, lead, and nickel), VOCs (benzene, chlorobenzene, 1,1-dichloroethene, and trichloroethene), and SVOCs (benzo(a)anthracene and chrysene). Monitoring wells NBCH009009 (upgradient), NBCH009003 (onsite), and NBCH009013 (downgradient) are located in the vicinity of SWMU 19. Benzene and lead exceeded the tap water RBC and treatment technique AL, respectively, in monitoring well NBCH00909. Barium and benzene were detected in monitoring well NBCH009003 above the background UTL and tap water RBC, respectively. Benzene and chlorobenzene were detected in monitoring well NBCH009013 above the tap water RBC. These findings indicate that soil-to-groundwater migration of barium, benzene and chlorobenzene from SWMU 19 may be impacting the shallow aquifer. Benzo(a)anthracene, chrysene, and 1,1-dichloroethene were detected in SWMU 19 soil at concentrations above the groundwater protection soil screening level in isolated areas of SWMU 19. Presently, these constituents have not been detected in the shallow groundwater of SWMU 9. Although the conservative screening process has indicated the potential for isolated soil to groundwater migration of benzo(a)anthracene, chrysene, and 1,1-dichloroethene, widespread impacts to the shallow aquifer are not expected. Nickel was not detected in SWMU 9 groundwater, while copper was detected in one SWMU 9 monitoring well (NBCH00906) which is located across Shipyard Creek from SWMU 19. Based on the limited impacts to the shallow aquifer and the tendency for inorganics to sorb to the soil matrix, SWMU 19 soil copper and nickel concentrations are not expected to adversely impact the shallow aquifer.

Benzo(a)anthracene was detected above the groundwater protection soil screening level in one SWMU 20 soil sample. Presently, benzo(a)anthracene has not been detected in the shallow groundwater of SWMU 9. Although the conservative screening process has indicated the potential for isolated soil to groundwater migration of benzo(a)anthracene, widespread impacts to the shallow aquifer are not expected.

SWMU 121 constituents which exhibit the potential for soil-to-groundwater transfer, based on comparison of concentrations in soil to groundwater protection soil screening criteria or background UTLs include acrylonitrile, barium, benzo(a)anthracene, chromium, chrysene, cobalt, copper, lead, mercury, nickel, selenium, thallium, vanadium and zinc. Monitoring well NBCH009001, positioned downgradient of SWMU 121, exhibited lead and vanadium concentrations of 17.4 μg/L and 101 μg/L, respectively, which are above the treatment technique AL for lead (15 μg/L) and the tap water RBC for vanadium (26 μg/L). Barium and copper were also detected in the downgradient monitoring well at concentrations below the tap water RBCs. These findings indicate that SWMU 121 soil concentrations of barium, copper, lead and vanadium may be impacting the shallow aquifer. Chromium, cobalt, mercury, selenium, thallium, vanadium, and zinc were detected above their background UTLs or groundwater protection SSLs infrequently in SWMU 121 surface soil and were not detected in the downgradient monitoring well. Of these inorganic constituents, only cobalt exceeded its background UTL in SWMU 121 subsurface soil. SWMU 121 soil concentrations of chromium, mercury, selenium, thallium, vanadium, and zinc are not expected to impact the shallow aquifer. Current groundwater results indicate that cobalt is not a soil-to-groundwater migration concern; however, quarterly groundwater sample results should be reviewed to confirm or refute this conclusion. Acrylonitrile, benzo(a)anthracene, and chrysene were detected in SWMU 121 surface soil at concentrations above the groundwater protection soil screening level. Concentrations of these constituents do not exceed the SSLs in the subsurface soil and have not been detected in the downgradient monitoring well, indicating that their soil concentrations are protective of the shallow aquifer.

AOCs 649 and 650 contaminants with the potential to transfer from soil to groundwater, based on comparison of concentrations in soil and shallow groundwater to the groundwater protection soil screening criteria or background UTLs, include acrylonitrile, barium, benzo(a)anthracene, chrysene, copper, lead, mercury, and nickel. Monitoring wells near AOCs 649 and 650 (NBCH009002 and NBCH009009) exhibited barium and lead impacts. Barium was detected in monitoring well NBCH009010 at 383 μg/L, above the background UTL of 323 μg/L. Lead was detected in monitoring well NBCH009009 at 52.6 μg/L, exceeding the USEPA treatment technique AL of 15 μg/L. These findings indicate that at AOC 649 and/or 650, soil concentrations of barium and lead may be impacting the shallow aquifer. Mercury and nickel were detected above groundwater SSLs or background UTLs infrequently in AOCs 649 and 650 surface soil, and copper exceeded the background UTL in 10 of 19 surface soil samples. Copper, mercury, and nickel did not exceed the groundwater protection SSLs or background

UTLs in AOCs 649 and 650 subsurface soil and were not detected in nearby monitoring wells. These findings suggest that AOC soil concentrations of copper, mercury, and nickel are protective of the shallow aquifer. Acrylonitrile, benzo(a)anthracene, and chrysene were detected above the groundwater protection SSL in AOC 649 and 650 surface soil. These organics were not detected in either the subsurface soil at AOCs 649 and 650 or in overall SWMU 9 groundwater. This indicates that while conservative screening shows a potential for isolated soil to groundwater migration for acrylonitrile, benzo(a)anthracene, and chrysene, widespread impacts to the shallow aquifer from AOCs 649 and 650 are not expected.

AOC 654 constituents with the potential for soil-to-groundwater transfer, based on comparison of concentrations in soil to the groundwater protection soil screening criteria or background UTLs, include acetone, copper, and methylene chloride. All three were detected above their groundwater protection SSLs or background UTLs infrequently in AOC 654 soil. Samples from monitoring wells near AOC 654 (NBCH009004 and NBCH009008) contained none of these constituents. This suggests that AOC 654 soil concentrations are protective of the shallow aquifer.

5.3.2 SWMU 9 — Groundwater-to-Surface Water Cross-Media Transport

Table 5.3.2 summarizes the groundwater-to-surface water transfer qualitative screening process. No organic compounds were detected in surface water samples collected at SWMU 9. Surface water contained a number of inorganic chemicals which were detected in shallow groundwater. Of the chemicals detected in both groundwater and surface water, chromium, copper, and lead exceed the saltwater chronic WQC. Chromium was detected in SWMU 9 surface water at concentrations of 221, 200, and 194 μg/L, which exceed the WQC of 50 μg/L at locations 009W001, 009W004 and 009W012. Copper was detected in SWMU 9 surface water at concentrations of 40.7 and 50.8 μg/L, which exceed the WQC of 2.9 μg/L at locations 009W001 and 009W004. Lead was detected in SWMU 9 surface water at a concentration of 73 μg/L, which exceeds the WQC of 8.5 μg/L at location 009W004. The qualitative screening process also identified nine additional contaminants (cadmium, 4,4'-DDT, endosulfan I, mercury, pentachlorophenol, selenium, silver, and zinc) detected in groundwater only which have published WQC protective of aquatic life. Current surface water data indicate that groundwater concentrations of these compounds have not impacted surface water habitats associated with SWMU 9.

Quantitative screening identified nine VOCs (benzene, carbon disulfide, chlorobenzene, 1,2-dichloroethane, 1,2-dichloroethene, ethylbenzene, methylene chloride, trichloroethene and vinyl chloride), 13 SVOCs (azobenzene, benzidine, bis[2-chloroethyl]ether, 1,4-dichlorobenzene, 2,4-dimethylphenol, bis[2-ethylhexyl]phthalate, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclopentadiene, hexachloroethane, 2-methylphenol, 4-methylphenol and pentachlorophenol), chlorinated dibenzodioxin/dibenzofurans, and nine inorganics (antimony, arsenic, barium, beryllium, chromium, copper, lead, selenium and vanadium) which were detected in groundwater above their tap water RBCs or background UTLs.

Of the inorganics identified in the quantitative screening, barium is most widespread, exceeding the background UTL in 7 of 20 shallow monitoring wells in SWMU 9. The rest of these inorganics exceeded their tap water RBCs or background UTLs infrequently in SWMU 9 shallow groundwater. No identifiable inorganic "hot spot" is apparent in SWMU 9 shallow groundwater. Detections of chromium, copper and lead in SWMU 9 surface water in excess of the saltwater chronic WQC indicate that migration from groundwater to surface water may be significant for these inorganics in terms of ecological impacts. It should be mentioned, however, that no reference surface water samples have been collected. The concentrations of chromium, copper, and lead reported in surface water may be representative of ambient water quality, and not indicative of any groundwater-to-surface water transport. The Zone J RFI will provide additional data interpretation relative to this point. Risk management decisions associated with concerns related to this migration pathway should be deferred until a comprehensive surface water dataset is complete.

Of the VOCs and SVOCs identified in the quantitative screening, benzene and chlorobenzene contamination in excess of tap water RBCs, are the most widespread. Benzene exceeds the tap water RBC in 10 of the 20 shallow monitoring wells and chlorobenzene exceeds its tap water RBC in eight of the 20 shallow monitoring wells. Generally, VOC and SVOC contamination is confined to monitoring wells NBCH009007, NBCH009013, and NBCH009014, (located near SWMU 19 and 20) with isolated pockets of contamination found in monitoring wells NBCH009010 and NBCH009016. Groundwater travel times from SWMU 19 and SWMU 20 to Shipyard Creek range from 75 years (SWMU 20) to 116 years (SWMU 19). In addition, the ability for soil to retard the movement of contaminants in the water table and expected dilutional effects upon transport through the vadose zone, combine to indicate that groundwater-to-surface water transport would be a slow and possibly unconfirmable migration pathway for SWMU 9.

Methylene chloride is considered the most mobile of the SWMU 9 groundwater organic constituents based on its ability to partition to water. NBCH009007 is the monitoring well nearest the "hot spot" for SWMU 9 organic contamination. Based on the retardation factor calculated for methylene chloride, travel time from monitoring well NCBH009007 to Shipyard Creek is estimated to be 105 years. Benzene's travel time from the closest monitoring well (NBCH009014) to Shipyard Creek was also evaluated. Of the organics detected in monitoring well NBCH009014, benzene is the most mobile in groundwater based on its ability to partition to water. This travel time is estimated to be 20 years. Currently, available data have identified no VOC or SVOC impacts to SWMU 9 surface water. Based on predicted transport characteristics of organic groundwater contaminants reported at SWMU 9, significant groundwater-to-surface water transport would not be expected. Additional surface water data will be collected from Shipyard Creek as part of the Zone J RFI sampling effort. This information will be evaluated in conjunction with existing SWMU 9 surface water and groundwater data to provide empirical support for these conclusions.

Chlorinated dibenzodioxins/dibenzofurans were detected in SWMU 9 monitoring wells NBCH009002, NBCH009005, and NBCH009015 at concentrations above the tap water RBC. Based on a K_{oc} value of 3,300,000, chlorinated dibenzodioxins/dibenzofurans are not expected to migrate within the shallow aquifer due to a strong affinity for the soil matrix.

5.3.3 SWMU 9 — Soil-to-Air Cross-Media Transport

For purposes of this assessment, SWMU 9 was considered to encompass SWMUs 19, 20 and 121 and AOCs 649, 650, and 654. No VOCs were detected in AOC 650 surface soil. As a result, it does not appear in the screening assessment. Table 5.3.3 lists the VOCs detected in surface soil samples collected at the other SWMUs/AOCs that make up overall SWMU 9 along with corresponding soil-to-air volatilization screening concentrations. A conservative soil-to-air screening value of 10,000 mg/kg was used for 2-butanone. The maximum surface soil concentration of no volatile compound exceeded its corresponding soil-to-air volatilization screening level except 1,1-dichloroethene at SWMU 19. As a result, the soil-to-air migration pathway would not be expected to be significant at SWMUs 20 and 121 and AOCs 649 and 654.

1,1-Dichloroethene was detected at SWMU 19 in a single surface soil sample at a concentration of 0.063 mg/kg, compared to the soil-to-air volatilization screening level of 0.04 mg/kg. The screening level was derived to represent the acceptable mean concentration on a 30-acre site. This approach assumes that a homogeneous source exists which can consistently emit 1,1-dichloroethene at a rate which will result in unacceptable ambient air concentrations. The severely limited extent of soil impacts reported at SWMU 19 indicate that the source strength onsite is far less than that assumed in the screening level development model. As a result, it was concluded that the single 1,1-dichloroethene hit in surface soil does not represent a viable threat to ambient air quality via volatilization.

Additional discussion with respect to groundwater to air migration can be found in the Focused Field Investigation (E/A&H, 1996). This investigation identified benzene, chloroform, 1,4-dichlorobenzene, 1,2,4-trimethylbenzene, dichlorofluoromethane, and trichlorofluoromethane as COCs based on health risks due their presence in indoor air of buildings located adjacent to SWMU 9. Sampling of the indoor air provided data to be used to estimate exposure to the building occupants and subsequently, provided the basis to establish the list of COCs. The FFI concludes that while benzene, 1,4-dichlorobenzene, and trichlorofluoromethane were identified in SWMU 9 shallow groundwater, it is unlikely that SWMU 9 landfill acts as a source. This conclusion is reached based on the lack of a viable migration route between the buildings and the observed shallow groundwater contamination. Benzene was detected in monitoring wells NBCH00901, NBCH00903, NBCH00907, NBCH00909, NBCH00910, NBCH00912, NBCH00913, NBCH00914, and NBCH00916. 1,4-Dichlorobenzene was detected in monitoring wells NBCH00910, NBCH00913, and NBCH00914. Trichlorofluoromethane was detected in monitoring well NBCH00907. With the exception of NBCH00910, each well in which FFI-based COCs were identified are located in the western portion of SWMU 9. NBCH00910 is in the center of SWMU 9. The FFI buildings are located east and northeast of SWMU 9. Considering the direction of groundwater flow from SWMU 9 (south to southwest), any contaminant migration in the center or western portion of SWMU 9 groundwater would tend to move away from the buildings in question. Monitoring wells NBCH00905, NBCH00908, and NBCH00911, located between the FFI buildings and impacted SWMU 9 monitoring wells, did not contain any of the FFI COCs.

Benzene and chloroform were identified at SWMU 19 in a single surface soil sample at concentrations well below their soil to air screening concentrations. Once again, the migration pathway connecting the former landfill and the buildings is not supported based on the location and limited extent of benzene and chloroform soil impacts. Observed soil contamination in the SWMUs/AOCs located within the former landfill support the FFI conclusion that the SWMU 9 landfill is an unlikely source of indoor air contamination in the buildings investigated as part of the FFI.

5.3.4 SWMU 9 — Soil-to-Sediment Cross-Media Transport

For the purposes of this discussion, drainage patterns for SWMU 9 were examined relative to sediment sample locations. The cap material for the former landfill that constituted SWMU 9 has a high sand fraction which promotes the infiltration rather than the runoff of rainwater. Surface soil sampling locations at SWMUs 19, 20, and 121 and AOCs 649, 650, and 654 were related to nearby sediment locations to evaluate the potential for erosion of contaminated surface soil to occur through examination of currently manifested impacts. SWMUs 19, 20, and 121 are near sediment locations 009M000101, 009M000201, 009M000301, 009M000401, and 009M000501. AOC 654 surface soil has the potential to impact sediment locations 009M001201, 009M001401, and 009M001501. AOCs 649 and 650 are not near any sediment sample locations and were not considered in this discussion.

Table 5.3.4 summarizes the qualitative screening for the surface soil-to-sediment contaminant transfer process. Contaminants found in both the surface soil samples collected from SWMUs 19, 20, and 121 and the nearby sediment sample locations include one VOC (carbon disulfide), four SVOCs (benzo[a]pyrene equivalents, bis[2-ethylhexyl]phthalate, fluoranthene, and pyrene), three PCB congeners (Aroclors-1248, 1254, and 1260), three chlorinated pesticides (4,4'-DDD, 4,4'-DDE and 4,4'-DDT), chlorinated dibenzodioxins/dibenzofurans, and 15 inorganics (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, vanadium and zinc). Of these contaminants, Aroclor-1248, carbon disulfide, 4,4'-DDE, and 4,4'-DDT were detected in sediment at concentrations nearly one order of magnitude higher than in soil. Aldrin and beta-BHC were detected in sediment only and cannot be directly related to a potential surface soil source.

Contaminants found in both the surface soil samples collected from AOC 654 and the nearby sediment sample locations include three VOCs (acetone, methylene chloride and toluene), two SVOCs (benzo[a]pyrene equivalents and fluoranthene), four pesticides (alpha-chlordane, gamma-chlordane, 4,4'-DDE, and 4,4'-DDT), chlorinated dibenzodioxins/dibenzofurans, and 14 inorganics (aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, vanadium, and zinc). Acenaphthene, Aroclor-1260, chlorobenzene, 4,4'-DDD, fluorene, phenanthrene, and pyrene were detected in sediment only and cannot be directly related to concentrations of these contaminants in surface soil.

Although evidence exists that contaminants in SWMU 19, 20, 121 and AOC 654 surface soil have the potential to form contaminated sediments, aspects of the former landfill portion of SWMU 9 may contribute to contamination found in sediments as well. With regard to additional migration of contaminated sediments, tidal influence is likely to result in the formation of predictable depositional zones of sediment based on tidal action. This would result in impacts to ecological environments, which are addressed in Section 7.

5.3.5 SWMU 9 — Fate and Transport Summary

Table 5.3.5 lists all the contaminants found to be significant in terms of fate and transport with a notation of the significant migration pathways for each contaminant.

Table 5.3.1
Chemicals Detected in Soil
Comparison to Groundwater Protection SSL or Background UTL
NAVBASE-Charleston, Zone H, SWMUs 9,19,20,121 and AOCs 649,650,654

Parameter	Units	SWMU 19 Surface Soil	SWMU 19 Subsurface Soil	SWMU 20 Surface Soil	SWMU 20 Subsurface Soil	SWMU 121 Surface Soil	SWMU 121 Subsurface Soil	AOC 649,650,651 Surface Soil	AOC 649,650,651 Subsurface Soil	AOC 654 Surface Soil	AOC 654 Subsurface Soil	Ground-Water Protection SSL	Detected in Ground-water
Acenaphthene	ug/kg	217	360	210	ND	130	ND	ND	ND	ND	ND	20000	I,II
Acenaphthylene	ug/kg	ND	130	ND	ND	590	ND	ND	ND	ND	ND	20000	
Acetone	ug/kg	33	47	ND	ND	193.5	ND	25.2	ND	4000	1700 *	800	I,II
Acrylonitrile	ug/kg	ND	ND	ND	ND	34.5	ND *	36.9	ND *	ND	ND	0.04	
Aluminum	mg/kg	11900	8210	ND	ND	16000	15500	10900	3280	6890	6530	46180	I,II
Anthracene	ug/kg	357	670	450	170	610	ND	250	ND	ND	130	430000	
Antimony	mg/kg	726	1.4	ND	ND	7.3	ND	1.6	ND	ND	ND	NDA	I (x)
Aroclor-1248	ug/kg	ND	ND	ND	ND	160	37	52	30	ND	ND	8200	
Aroclor-1254	ug/kg	2300	ND	ND	ND	4300	82	407	30	ND	ND	8200	
Aroclor-1260	ug/kg	560	ND	ND	ND	1100	88	ND	ND	ND	ND	8200	
Arsenic	mg/kg	22.1	8.3	ND	ND	18.7	10.7	9.5	3	7.7	18.4	35.52	I,II (x)
delta-BHC	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	1.2	ND	6	
Barium	mg/kg	128	64.1 *	ND	ND	530	89.7 *	57.9	ND *	38.7	ND	43.8	I,II (x)
Benzene	ug/kg	64	ND *	ND	ND	ND	ND	ND	ND	ND	ND	20	I,II (x)
Benzo(g,h,i)perylene	ug/kg	215	600	250	ND	780	93	1100	ND	ND	ND	98000	
Benzo(a)pyrene	ug/kg	604	1400	820	430	1700	200	2000	ND	ND	ND	4000	
Benzo(a)anthracene	ug/kg	811	1700 *	950	580 *	1900	160 *	1900	ND *	ND	140	700	
Benzo(b)fluoranthene	ug/kg	935	1700	1400	680	2700	200	4000	ND	110	ND	4000	
Benzo(k)fluoranthene	ug/kg	712	1200	660	400	2200	230	130	ND	ND	140	4000	
Chrysene	ug/kg	755	1600 *	940	610	2000	170 *	1900	ND *	ND	ND	1000	
Dibenzo(a,h)anthracene	ug/kg	ND	250	100	ND	280	ND	390	ND	ND	ND	11000	
Indeno(1,2,3-cd)pyrene	ug/kg	240	590	260	ND	750	ND	910	ND	ND	ND	35000	
Benzoic acid	ug/kg	ND	ND	ND	ND	ND	ND	269	ND	ND	ND	28000	I
Beryllium	mg/kg	3	0.61	ND	ND	14.6	2.6	1.1	0.2	0.49	0.59	180	II (x)
2-Butanone (MEK)	ug/kg	ND	ND	ND	ND	37.1	ND	ND	ND	ND	ND	570	I
Butylbenzylphthalate	ug/kg	2300	150	190	430	2600	ND	1540	ND	ND	ND	6800	II
Cadmium	mg/kg	1.8	0.64	ND	ND	2.5	ND	0.39	ND	0.97	1.5	6	I,II
Carbon disulfide	ug/kg	9.9	ND	ND	ND	ND	ND	4.8	ND	ND	11	1400	I,II (x)
alpha-Chlordane	ug/kg	9.35	ND	ND	ND	ND	ND	11.6	2	69.1	ND	2000	
gamma-Chlordane	ug/kg	4	ND	ND	ND	4	ND	6	ND	41	ND	2000	
Chlorobenzene	ug/kg	64	ND *	ND	ND	ND	ND	5.18	ND	ND	ND	60	I,II (x)
Chloroform	ug/kg	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	300	
Chromium	mg/kg	49.2	20.7	ND	ND	210	50.8 *	24.4	12.3	53.3	70.7	85.65	I,II (x)
Cobalt	mg/kg	43.3	5.5 *	ND	ND	97.2	15.9 *	9.5	1.5	3.1	4.3	14.88	I,II
Copper	mg/kg	3040	309 *	ND	ND	4060	680 *	357	24.6 *	57.1	13.1 *	31.62	I,II (x)
Cyanide	mg/kg	ND	ND	ND	ND	9.9	ND	ND	ND	2	1	NDA	
2,4-D	ug/kg	41.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	1700	
4,4'-DDD	ug/kg	6	10	ND	ND	ND	ND	8	ND	ND	ND	700	II
4,4'-DDE	ug/kg	5	12	ND	ND	20.5	ND	10.2	3	6.15	ND	500	II
4,4'-DDT	ug/kg	16	ND	ND	ND	14	ND	7	ND	10	ND	1000	I
Dibenzofuran	ug/kg	124	200	220	ND	89	ND	56.5	ND	ND	ND	12000	I,II
Diethylphthalate	ug/kg	ND	ND	ND	ND	85.2	ND	ND	ND	ND	ND	11000	I
Di-n-butylphthalate	ug/kg	1100	ND	ND	ND	ND	ND	222	ND	ND	ND	12000	I,II

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Chemicals Detected in Soil
Comparison to Groundwater Protection SSL or Background UTL
NAVBASE-Charleston, Zone H, SWMUs 9,19.20,121 and AOCs 649,650,654

Parameter	Units	SWMU 19		SWMU 20		SWMU 121		AOC 649,650,651		AOC 654		Ground-Water Protection SSL	Detected in Ground-water
		Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil		
1,1-Dichloroethene	ug/kg	63	ND *	ND	ND	ND	ND	1.9	ND	ND	ND	30	
Di-n-octylphthalate	ug/kg	150	ND	ND	ND	ND	ND	98	ND	ND	ND	100000000	
Dioxin (TCDD TEQ)	ng/kg	45.5459	ND	6.2585	ND	194.2297	ND	8.3816	ND	0.7166	ND	280	I
Endosulfan sulfate	ug/kg	ND	ND	ND	ND	ND	ND	7	ND	ND	ND	400	
Endosulfan II	ug/kg	2.1	ND	ND	ND	25	ND	ND	ND	ND	ND	400	
Endrin	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	400	
Endrin aldehyde	ug/kg	52	ND	ND	ND	24.3	ND	ND	ND	ND	ND	400	
Ethylbenzene	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	4.5	ND	5000	I,II (x)
bis(2-Ethylhexyl)phthalate	ug/kg	9700	260	8165	380	1000	ND	504	ND	124	ND	11000	I (x)
Fluoranthene	ug/kg	1590	2800	2000	1300	3900	330	3200	ND	110	780	98000	I,II
Fluorene	ug/kg	218.5	250	340	ND	200	ND	ND	ND	ND	ND	16000	I
Heptachlor	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	60	
Heptachlor epoxide	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	4.1	ND	30	
Lead	mg/kg	6170	238 *	ND	ND	2770	508 *	347	13.9 *	32.7	ND	118	I,II (x)
Manganese	mg/kg	320	109	ND	ND	1020	251	124	12.4	57.2	50.9	1412	I,II
Mercury	mg/kg	2.1	0.3	ND	ND	3.5	0.7 *	6.9	ND *	0.23	ND	3	I,II
Methylene chloride	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	25	36 *	10	II (x)
4-Methyl-2-Pentanone	ug/kg	ND	ND	ND	ND	2.4	ND	ND	ND	ND	ND	910	I,II
2-Methylnaphthalene	ug/kg	240	160	100	ND	470	ND	322	ND	ND	ND	3000	I,II
4-Methylphenol	ug/kg	200	ND	ND	ND	ND	ND	ND	ND	ND	ND	600	I,II (x)
Naphthalene	ug/kg	480	190	99	ND	330	ND	270	ND	ND	ND	3000	I,II
Nickel	mg/kg	282	22.5 *	ND	ND	995	142 *	39.2	5.7 *	17.9	30	33.38	
Phenanthrene	ug/kg	1195	2500	1900	780	2200	160	800	ND	ND	ND	98000	I
Phenol	ug/kg	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	4900	I,II
Pyrene	ug/kg	1430	3200	2800	1200	3400	310	3300	ND	ND	490	140000	
Selenium	mg/kg	1.1	ND	ND	ND	3.2	ND *	0.42	ND	2.6	3	3	I,II
Silver	mg/kg	0.92	ND	ND	ND	1.2	ND	ND	ND	ND	ND	NDA	I
TPH	mg/kg	170	ND *	ND	ND	150	ND *	980	ND *	ND	ND	100	
Thallium	mg/kg	0.32	ND	ND	ND	2.7	ND *	0.54	ND	ND	ND	1.3	I
Tin	mg/kg	43.8	ND	ND	ND	19.7	ND	22.3	ND	ND	ND	NDA	
Toluene	ug/kg	72	7	11	5	13	ND	5.9	ND	10	17	5000	I,II
Trichloroethene	ug/kg	54	ND *	ND	ND	ND	ND	ND	ND	ND	ND	20	II (x)
Vanadium	mg/kg	43.5	24.4	ND	ND	470	64.8 *	35.4	8.4	29.4	37.1	131.6	I,II (x)
Xylene (total)	ug/kg	1.6	ND	ND	ND	6	ND	7.1	ND	44.7	ND	74000	I,II
Zinc	mg/kg	2800	359	ND	ND	15100	1750 *	507	ND	81.8	66.4	4200	I,II

* - Exceeds groundwater protection SSL
I - First quarter groundwater; II - Second quarter groundwater
(x)-Exceeds tap water RBC in shallow groundwater
ug/kg - microgram per kilogram
mg/kg - milligram per kilogram

Table 5.3.2
Chemicals Detected in Groundwater and Surface Water
Comparison of Groundwater to Tap Water Risk-based Concentrations for SWMU 9
NAVBASE-Charleston, Zone H, SWMU 9

Parameter	Maximum Conc. Detected in Shallow Ground Water	Maximum Conc. Detected in Surface Water	Media			Shallow GW Exceeds Tap Water RBC or UTL	Tap Water RBC or UTL *	Units
Acenaphthene	20	ND	GS1	GS2		NO	220	UG/L
Acetone	230	ND	GS1	GS2		NO	370	UG/L
Aluminum	1050	19800	GS1	GS2	SW	NO	3700	UG/L
Antimony	18.8	ND	GS1			YES	1.5	UG/L
Arsenic	75	14.6	GS1	GS2	SW	YES	27.99	UG/L
Azobenzene	2.6	ND	GS1			YES	0.61	UG/L
Barium	1410	93.2	GS1	GS2	SW	YES	323	UG/L
Benzene	180	ND	GS1	GS2		YES	0.36	UG/L
Benzidine	54	ND	GS1			YES	0.00029	UG/L
Benzoic acid	69	ND	GS1			NO	15000	UG/L
Beryllium	1.4	0.48		GS2	SW	YES	0.016	UG/L
2-Butanone (MEK)	10.6	ND	GS1			NO	190	UG/L
Butylbenzylphthalate	2.9	ND		GS2		NO	730	UG/L
Cadmium	1.8	2.4	GS1	GS2	SW	NO	1.8	UG/L
Carbon disulfide	80.5	ND	GS1			YES	2.1	UG/L
Chlorobenzene	1300	ND	GS1	GS2		YES	3.9	UG/L
Chloroethane	7	ND	GS1	GS2		NO	860	UG/L
bis(2-Chloroethyl)ether	140	ND	GS1			YES	0.0092	UG/L
4-Chloro-3-methylphenol	3.1	ND	GS1			YES	NA	UG/L
2-Chlorophenol	8.6	ND	GS1	GS2		NO	18	UG/L
Chromium	1460	221	GS1		SW	YES	18	UG/L
Cobalt	2.8	4.2	GS1	GS2	SW	NO	220	UG/L
Copper	154	50.8	GS1	GS2	SW	YES	140	UG/L
Cyanide	0.05	ND	GS1			NO	75	UG/L
4,4'-DDD	0.1	ND		GS2		NO	0.28	UG/L
4,4'-DDE	0.03	ND		GS2		NO	0.2	UG/L
4,4'-DDT	0.06	ND	GS1			NO	0.2	UG/L
Dibenzofuran	7.5	ND	GS1	GS2		NO	15	UG/L
Di-n-butylphthalate	3.4	ND	GS1			NO	370	UG/L
1,2-Dichlorobenzene	4.9	ND	GS1	GS2		NO	27	UG/L
1,4-Dichlorobenzene	9.05	ND	GS1	GS2		YES	0.44	UG/L
1,2-Dichloroethane	59	ND	GS1	GS2		YES	0.12	UG/L
1,2-Dichloroethene (total)	160	ND	GS1	GS2		YES	5.5	UG/L
Diethylphthalate	3.05	ND	GS1			NO	2900	UG/L
2,4-Dimethylphenol	1700	ND	GS1	GS2		YES	73	UG/L
Dioxin (TCDD TEQ)	2.502	ND	GS1			YES	0.5	PG/L
Diphenylamine	9.6	ND	GS1			NO	91	UG/L
Endosulfan 1	0.07	ND		GS2		NO	22	UG/L
Ethylbenzene	150	ND	GS1	GS2		YES	130	UG/L
bis(2-Ethylhexyl)phthlate	5.2	ND	GS1			YES	4.8	UG/L
Fluoranthene	3.9	ND	GS1	GS2		NO	150	UG/L
Fluorene	7.5	ND	GS1			NO	150	UG/L
Hexachlorobenzene	74	ND		GS2		YES	0.0066	UG/L
Hexachlorobutadiene	2.8	ND		GS2		YES	0.14	UG/L
Hexachlorocyclopentadiene	11	ND	GS1			YES	0.015	UG/L
Hexachloroethane	2.7	ND		GS2		YES	0.61	UG/L

Table 5.3.2
Chemicals Detected in Groundwater and Surface Water
Comparison of Groundwater to Tap Water Risk-based Concentrations for SWMU 9
NAVBASE-Charleston, Zone H, SWMU 9

Parameter	Maximum Conc. Detected in Shallow Ground Water	Maximum Conc. Detected in Surface Water	Media			Shallow GW Exceeds Tap Water RBC or UTL	Tap Water RBC or UTL *	Units
Lead	52.6	73	GS1	GS2	SW	YES	15	UG/L
Manganese	1990	329	GS1	GS2	SW	NO	3391	UG/L
Mercury	0.55	ND	GS1	GS2		NO	1.1	UG/L
Methylene chloride	130	ND		GS2		YES	4.1	UG/L
4-Methyl-2-Pentanone (MIBK)	10	ND	GS1	GS2		NO	290	UG/L
2-Methylnaphthalene	7.7	ND	GS1	GS2		NO	150	UG/L
2-Methylphenol	270	ND	GS1	GS2		YES	180	UG/L
4-Methylphenol	4400	ND	GS1	GS2		YES	18	UG/L
Naphthalene	9.9	ND	GS1	GS2		NO	150	UG/L
N-Nitrosodiphenylamine	3.4	ND	GS1			NO	14	UG/L
Pentachlorophenol	24	ND	GS1			YES	0.56	UG/L
Phenanthrene	9.8	ND	GS1			NO	150	UG/L
Phenol	51.766	ND	GS1	GS2		NO	2200	UG/L
Selenium	28.8	ND	GS1	GS2		YES	18	UG/L
Silver	4.4	ND	GS1			NO	18	UG/L
2,4,5-T	0.56	ND	GS1			NO	37	UG/L
Thallium	6.4	6.6	GS1		SW	NO	7.66	UG/L
Toluene	37	ND	GS1	GS2		NO	75	UG/L
Trichloroethene	9	ND		GS2		YES	1.6	UG/L
Trichlorofluoromethane	52	ND		GS2		NO	130	UG/L
Vanadium	101	108	GS1	GS2	SW	YES	26	UG/L
Vinyl chloride	720	ND	GS1	GS2		YES	0.019	UG/L
Xylene (total)	600	ND	GS1	GS2		NO	1200	UG/L
Zinc	19.8	264	GS1		SW	NO	1100	UG/L

* - See Table 5.2-1
GS1 - Groundwater, round 1
GS2 - Groundwater, round 2
SW - Surface Water
RBC - Risk based concentration
UTL - Background upper tolerance limit for Zone H shallow groundwater
UG/L - microgram per liter

TABLE 5.3.3
Soil-to-Air Volatilization Screening Analysis for SWMUs 19, 20, 121, and AOCs 649 and 654
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil SWMU 19	SWMU 20	SWMU 121	AOC 649	AOC 654	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.033	ND	0.1935	0.0252	4	62000	MG/KG	NO
Benzene	0.064	ND	ND	ND	ND	0.5	MG/KG	NO
2-Butanone	ND	ND	0.0371	ND	ND	10000 +	MG/KG	NO
Carbon disulfide	0.0099	ND	ND	0.0048	ND	11	MG/KG	NO
Chlorobenzene	0.064	ND	ND	0.0018	ND	94	MG/KG	NO
Chloroform	0.0015	ND	ND	ND	ND	0.2	MG/KG	NO
1,1-Dichloroethene	0.063	ND	ND	ND	ND	0.04	MG/KG	YES
Ethylbenzene	ND	ND	ND	ND	0.0045	260	MG/KG	NO
Methylene chloride	ND	ND	ND	ND	0.025	7	MG/KG	NO
Toluene	0.072	0.011	0.013	0.0049	0.01	520	MG/KG	NO
Trichloroethene	0.054	ND	ND	ND	ND	3	MG/KG	NO
Xylene (total)	0.0016	ND	0.006	0.0071	0.0447	730	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentration Tables, March 1995.
+ - Screening value presented for 2-butanone was conservatively estimated at 10,000 mg/kg; actual may be higher.
ND - Not detected

Table 5.3.4
Chemicals Detected in Soil and Sediment
NAVBASE-Charleston, Zone H, SWMUs 9,19,20,121 and AOC 654

Parameter	SWMUs 19, 20, 121		Maximum Conc. Surface in Soil	Maximum Conc. in Sediment	AOC 654		Maximum Conc. Surface in Soil	Maximum Conc. in Sediment	Units
Acenaphthene	SS		244	ND		SED	ND	230	UG/KG
Acenaphthylene	SS		590	ND			ND	ND	UG/KG
Acetone	SS		130	ND	SS	SED	4000	350	UG/KG
Acrylonitrile	SS		34.5	ND			ND	ND	UG/KG
Aldrin		SED	ND	18			ND	ND	UG/KG
Aluminum	SS	SED	16000	21400	SS	SED	6890	11500	MG/KG
Ammonia	SS		25	ND	SS		25	ND	UG/KG
Anthracene	SS		610	ND			ND	ND	UG/KG
Antimony	SS	SED	146	2.9			ND	ND	MG/KG
Aroclor-1248	SS	SED	160	3000			ND	ND	UG/KG
Aroclor-1254	SS	SED	4300	690			ND	ND	UG/KG
Aroclor-1260	SS	SED	1100	770		SED	ND	890	UG/KG
Arsenic	SS	SED	22.1	15.6	SS	SED	7.7	14.5	MG/KG
beta-BHC		SED	ND	7			ND	ND	UG/KG
delta-BHC	SS		ND	ND	SS		1.2	ND	UG/KG
Barium	SS	SED	530	29.1	SS	SED	38.7	122	MG/KG
Benzene	SS		64	ND			ND	ND	UG/KG
Benzo(g,h,i)perylene	SS		780	ND			ND	ND	UG/KG
Benzo(a)pyrene Equivalents	SS	SED	2524.9	8.7	SS	SED	11	10.14	UG/KG
Benzoic acid	SS		ND	ND			ND	ND	UG/KG
Beryllium	SS	SED	14.6	1	SS	SED	0.49	1.1	MG/KG
2-Butanone (MEK)	SS		37.1	ND			ND	ND	UG/KG
Butylbenzylphthalate	SS		2600	ND			ND	ND	UG/KG
Cadmium	SS	SED	2.5	0.64	SS	SED	0.97	0.62	MG/KG
Carbon disulfide	SS	SED	9.9	150			ND	ND	UG/KG
alpha-Chlordane	SS		15.7	ND	SS	SED	46	29	UG/KG
gamma-Chlordane	SS		4	ND	SS	SED	57.7	26	UG/KG
Chlorobenzene	SS		64	ND		SED	ND	34	UG/KG
Chloroform	SS		1.5	ND			ND	ND	UG/KG
Chromium	SS	SED	210	291	SS	SED	53.3	47.5	MG/KG
Cobalt	SS	SED	97.2	5.7	SS	SED	3.1	3.9	MG/KG
Copper	SS	SED	4060	228	SS	SED	57.1	31.7	MG/KG
Cyanide	SS		9.9	ND	SS		2	ND	UG/KG
2,4-D	SS		41.8	ND			ND	ND	UG/KG
4,4'-DDD	SS	SED	6	91		SED	ND	11	UG/KG
4,4'-DDE	SS	SED	20.5	150	SS	SED	4	15	UG/KG
4,4'-DDT	SS	SED	16	140	SS	SED	10	51	UG/KG
Dibenzofuran	SS		220	ND			ND	ND	UG/KG
Diethylphthalate	SS		85.2	ND			ND	ND	UG/KG
Di-n-butylphthalate	SS		1100	ND			ND	ND	UG/KG
1,1-Dichloroethene	SS		63	ND			ND	ND	UG/KG
Di-n-octylphthalate	SS		150	ND			ND	ND	UG/KG
Dioxin (TCDD TEQ)	SS		194.2297	ND	SS		0.7166	ND	UG/KG
Endosulfan sulfate	SS		ND	ND			ND	ND	UG/KG
Endosulfan II	SS		25	ND			ND	ND	UG/KG
Endrin	SS		ND	ND	SS		2	ND	UG/KG
Endrin aldehyde	SS		52	ND			ND	ND	UG/KG

Table 5.3.4
Chemicals Detected in Soil and Sediment
NAVBASE-Charleston, Zone H, SWMUs 9,19,20,121 and AOC 654

Parameter	SWMUs 19, 20, 121		Maximum Conc. Surface in Soil	Maximum Conc. in Sediment	AOC 654		Maximum Conc. Surface in Soil	Maximum Conc. in Sediment	Units
Ethylbenzene	SS		ND	ND	SS		4.5	ND	UG/KG
bis(2-Ethylhexyl)phthalate (BEHP	SS	SED	9700	830	SS		110	ND	UG/KG
Fluoranthene	SS	SED	3900	9500	SS	SED	110	120	UG/KG
Fluorene	SS		340	ND		SED	ND	160	UG/KG
Heptachlor	SS		ND	ND	SS		1.1	ND	UG/KG
Heptachlor epoxide	SS		ND	ND	SS		3	ND	UG/KG
Lead	SS	SED	6170	107	SS	SED	32.7	92.2	MG/KG
Manganese	SS	SED	1020	274	SS	SED	57.2	124	MG/KG
Mercury	SS	SED	3.3	0.69	SS	SED	0.23	0.26	MG/KG
Methylene chloride	SS		ND	ND	SS	SED	25	72	UG/KG
4-Methyl-2-Pentanone (MIBK)	SS		2.4	ND			ND	ND	UG/KG
2-Methylnaphthalene	SS		470	ND			ND	ND	UG/KG
4-Methylphenol	SS		200	ND			ND	ND	UG/KG
Naphthalene	SS		620	ND			ND	ND	UG/KG
Nickel	SS	SED	995	37.3	SS	SED	17.9	17.9	MG/KG
Phenanthrene	SS		2200	ND		SED	ND	150	UG/KG
Phenol	SS		100	ND			ND	ND	UG/KG
Pyrene	SS	SED	3400	6400		SED	ND	130	UG/KG
Selenium	SS	SED	3.2	1.5	SS	SED	2.6	2.2	MG/KG
Silver	SS		1.2	ND			ND	ND	MG/KG
Total Petroleum Hydrocarbons (IR	SS		170	ND			ND	ND	UG/KG
Thallium	SS		2.7	ND			ND	ND	MG/KG
Tin	SS		43.8	ND			ND	ND	MG/KG
Toluene	SS		72	ND	SS		10	ND	UG/KG
Trichloroethene	SS		54	ND			ND	ND	UG/KG
Vanadium	SS	SED	470	52.2	SS	SED	29.4	47.4	MG/KG
Xylene (total)	SS		6	ND	SS		44.7	ND	UG/KG
Zinc	SS	SED	15100	387	SS	SED	81.8	147	MG/KG

SS - Surface soil
SED - Sediment
UG/KG - microgram per kilogram
MG/KG - millgram per kilogram

Table 5.3.5
Significant Migration Pathways for SWMUs 9, 19, 20, and 121; and AOCs 649, 650, and 654
NAVBASE-Charleston, Zone H

Parameter	SWMU 19 Soil to Ground Water	SWMU 20 Soil to Ground Water	SWMU 121 Soil to Ground Water	AOC 649 Soil to Ground Water	AOC 650 Soil to Ground Water	AOC 654 Soil to Ground Water	SWMU 9 Ground Water Migration	SWMU 9 Soil to Air
Barium	X		X	X	X			
Benzene	X						X	
Chlorobenzene	X						X	
Chromium							X *	
Copper			X				X *	
1,1-Dichloroethene								X
Lead			X	X	X		X *	
Vanadium			X					

* - Ecological impacts
** - Areal extent of contaminantion reduces significance
Sediment impacts evaluated in Section 7.0 Ecological Risk Assessment

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6.2.2 Baseline Risk Assessment for SWMU 13

6.2.2.1 Site Background and Investigative Approach

SWMU 13 was investigated to assess soil and groundwater potentially affected by site activities. SWMU 13 is a firefighting training area, at the northern boundary of Zone H. It includes buildings 204, 1303, 1306, 1309, 1310, 1313, 1744, and 1834, and several other structures. It is used to train personnel in firefighting techniques. Diesel fuel and gasoline are ignited in controlled burns in a contained, paved, and bermed area. Water and fuel drain into oil-water separators which discharge into the sewer system. Recovered petroleum products are recycled. A UST is in the northwest portion of the site.

Thirty-one surface soil samples from 28 locations were collected and analyzed from SWMU 13. Table 6.2.2.1 shows each surface soil sample location and lists the analytical methods used for each sample. First- and second-quarter groundwater samples were collected from nine shallow monitoring wells and analyzed for parameters similar to those for soil samples, as shown in Tables 6.2.2.2 and 6.2.2.3, respectively.

6.2.2.2 COPC Identification

Soil

As shown in Table 6.2.2.4, this HHRA focuses on the following COPCs for soil: cPAHs (as BEQs) and heptachlor. The results of the Wilcoxon rank sum test background comparisons of inorganic CPSSs that exceeded their corresponding risk-based screening values did not identify any additional COPCs. Therefore, the soil COPCs listed above were formally assessed. Petroleum hydrocarbons were identified in 10 of 23 surface soil samples reported at concentrations ranging between 75 and 730 mg/kg. Concentrations reported at five locations exceeded the 100 mg/kg TPH AL established for NAVBASE soil.

Groundwater

As shown in Table 6.2.2.5, no groundwater COPCs were identified at this site based on first-quarter groundwater monitoring results. Table 6.2.2.6 shows COPCs identified based on the second-quarter groundwater monitoring effort at SWMU 13. The Wilcoxon rank sum comparison for SWMU 13 indicated potassium concentrations were above background. Beryllium is the only groundwater COPC identified based on second-quarter groundwater monitoring data.

6.2.2.3 Exposure Assessment

Exposure Setting

The exposure setting at SWMU 13 is a firefighting training area. The mostly paved site is at the northern boundary of Zone H. The future use of this site is unknown although current plans indicate it will be a cargo terminal.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers and hypothetical future site residents. The current site users consist of firefighting trainees and instructors who use the area infrequently and for a short duration. The hypothetical future site worker scenario assumed site workers were continuously exposed to surface soil. A current site user's exposure would be less than that assumed for the hypothetical future site worker scenario because limited frequency of soil contact. The hypothetical site resident scenario was also included. Exposure projections (and resultant RGOs) for the future site worker will conservatively assess RME under current site use conditions.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of surface soil. The exposure pathways under the hypothetical future residential land use are the same as those for the future site worker. Uniform exposure was assumed for all sample locations. In addition, the future site worker scenario assumed continuous exposure to surface soil conditions. Groundwater was formally assessed for the site worker and hypothetical site resident ingestion pathway. Table 6.2.2.7 justifies exposure pathways assessed in this HHRA.

Exposure Point Concentrations

More than 10 surface soil samples were analyzed; therefore, UCLs were calculated, and the lesser of the maximum reported concentrations or the calculated UCLs was used as the EPC for each COPC in Table 6.2.2.8. Because there are fewer than 10 groundwater monitoring wells at SWMU 13, the maximum concentration reported for groundwater COPCs was used as the EPC for the groundwater pathway.

Soil

Table 6.2.2.8 presents the EPCs used in this HHRA for SWMU 13. Tables 6.2.2.9 and 6.2.2.10 present the CDIs calculated for the incidental ingestion and dermal contact exposure pathways, respectively.

Groundwater

Table 6.2.2.11 presents exposure estimates for ingestion of shallow groundwater.

6.2.2.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.4 of this report. Toxicological risk information is summarized in Table 6.2.2.12, and toxicological profiles are presented below for COPCs identified in Section 6.2.2.2.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1

Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the BAP is classified B2 based on insufficient human data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question, the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and is presented as the switching per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is based on data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells and transformed mammalian cells in culture. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.*** USEPA determined RfDs for only two of these compounds: pyrene's RfD_o is 0.03 mg/kg-day, and this RfD is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

Heptachlor is an insecticide which was used to control flies, mosquitoes, and field insects (Dreisbach et al., 1987). USEPA determined this compound to be a class B2 carcinogen, and determined the SF_o to be 4.5 $(mg/kg\text{-}day)^{-1}$. As listed in IRIS (search date 6/29/95), the classification is based on inadequate human data, but sufficient evidence exists from studies in which benign and malignant liver tumors were induced in three strains of mice of both sexes. Several structurally related compounds are liver carcinogens. The primary target organs for this pesticide are the liver and kidneys, and USEPA determined the RfD_o to be 0.0005 mg/kg-day. As listed in IRIS, the critical effect of this chemical is liver weight increases in males. The uncertainty factor was 300 and the modifying factor was 1.

Beryllium exposure via the inhalation route can inflame the lungs, a condition known as acute beryllium disease, as a result of short-term exposure to high concentrations. Removal from exposure reverses the symptoms. Chronic exposure to much lower concentrations of beryllium or beryllium oxide by inhalation has been reported to cause chronic beryllium disease, with symptoms including shortness of breath, scarring of the lungs, and berylliosis, which is noncancerous growths in the lungs of humans. Both forms of beryllium disease can be fatal, depending on the severity of the exposure. Additionally, a skin allergy may develop when soluble beryllium compounds come into contact with the skin of sensitized individuals (Gradient, 1991). An oral RfD of 0.0054 mg/kg-day has been set for beryllium based on a chronic oral bioassay (rats were the study species) which determined no adverse effect occurs at 0.54 mg/kg-day. Beryllium has been classified by USEPA as a group B2 carcinogen based on animal studies. It has been shown to induce lung cancer via inhalation in rats and monkeys, and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. Human epidemiology studies of beryllium are considered to be inadequate. As listed in IRIS (search date 6/28/95), beryllium has been shown to induce lung cancer via inhalation in rats and monkeys and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. Human epidemiology studies are inadequate. USEPA set an inhalation SF of 8.4 $(mg/kg\text{-}day)^{-1}$ and an oral SF of 4.3 $(mg/kg\text{-}day)^{-1}$. As listed in IRIS, of this chemical has no adverse critical effect. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfD in drinking water is 0.005 mg/kg-day.

Naphthalene, as well as ***2-methylnaphthalene***, are obtained from coal tar and are used as a moth repellant and as a synthetic intermediate. The primary effect of naphthalene is on the kidneys due to this compound's effect on the blood (Dreisbach et al., 1987). Naphthalene was determined to be a USEPA class D carcinogen (i.e., is not classified due to insufficient data). As listed in IRIS (search date 11/22/95), the classification is based on no human data and inadequate data from animal bioassays. Results from the National Toxicology Program (NTP), a two-year cancer bioassay (1991), suggest that naphthalene may be more appropriately classified as a possible human carcinogen (Group C under current USEPA guidelines). The NTP concluded, "Under the conditions of these two-year studies, there is no evidence of carcinogenic activity of naphthalene in male B6C3F1 mice exposed by inhalation to concentrations of 10 or 30 ppm for six hours daily, five days per week, for 103 weeks. There was some evidence of carcinogenic activity of naphthalene in female B6C3F1 mice, as indicated by the increased incidences of pulmonary alveolar/bronchiolar adenomas." USEPA determined the RfD_o to be 0.04 mg/kg-day, which was withdrawn from IRIS/HEAST.

The Wilcoxon rank sum comparison for SWMU 13 potassium concentrations indicated onsite potassium concentrations are elevated with respect to background. Magnesium, potassium, iron, calcium, and sodium are all essential nutrients. These elements were eliminated from formal assessment because they are essential elements. These nutrients would be expected to be indigenous to the soil. In vitamin supplements, 100, 40, 18, and 162 mg are the daily doses for magnesium, potassium, iron, and calcium, and approximately 70 mg of sodium is found in the typical soda.

6.2.2.5 Risk Characterization

Surface Soil

Exposure to surface soil onsite was analyzed under both residential and industrial (site worker) scenarios. For each scenario, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 6.2.2.13 and 6.2.2.14 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soil.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for SWMU 13 surface soil is 8E-7. The dermal pathway ILCR is 4E-7. Carcinogenic PAHs (as BEQs) were the primary contributor to ILCR for each pathway. Heptachlor accounted for approximately one order of magnitude less than the ILCR estimated for BEQs.

The computed HI for the adult resident was 0.00003 for the soil ingestion pathway. The computed HI for the child ingestion pathway was 0.0003. The dermal contact pathway HIs were 0.00003 and 0.00009 for both the adult resident and the child resident. The only contributor to hazard for either soil pathway was heptachlor.

Hypothetical Site Workers

Site worker ILCRs are 9E-8 and 2E-7 for the ingestion and dermal contact pathways, with cPAHs (as BEQs) as the primary contributor to ILCR for each pathway. Heptachlor accounted for approximately one order of magnitude less than the ILCR estimated for BEQs. The HIs for the ingestion and dermal pathways were 0.00001 and 0.00002 for the site worker scenario, and the sole contributor to the HIs was heptachlor.

The reported hits for BEQs were either from samples collected within 2 feet of an asphalt area or directly beneath the asphalt. PAHs are components of asphalt, and asphalt could contribute to the equivalent concentrations reported beneath or near the asphalt area. In addition, a fence currently prevents frequent trespass, and only workers engaged in short-term activities would be likely to enter the area.

Groundwater

Exposure to shallow groundwater was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion exposure was considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Table 6.2.2.15 presents the estimated carcinogenic risk and noncarcinogenic HQs associated with the potable use ingestion of shallow groundwater.

Future Site Residents

The projected ingestion-related ILCR from shallow groundwater was estimated to be 1E-5. The HIs for adult and child residential receptors were estimated to be 0.001 and 0.003, respectively. Beryllium was the sole contributor to both the ILCR and HIs, and was reported in only one monitoring well.

Future Site Workers

The projected ingestion related ILCR from shallow groundwater was 5E-6, and the site worker HI was estimated to be 0.0004. Beryllium was the sole contributor to both the ILCR and HIs.

Current Site Workers

Shallow groundwater is not currently a potable water source for SWMU 13 or other areas of Zone H. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and an HI threshold of 1.0 (unity). In Zone H HHRAs, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a cumulative HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is relatively conservative, because USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection algorithm provides a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process. The soil exposure scenarios were maintained in both instances. However, as described previously, the cumulative risk threshold used to identify COCs in this HHRA (1E-6) is two orders of magnitude more conservative.

Surface Soil

Hypothetical Site Residents (Future Land Use)

No risk- or hazard-based COCs were identified for the hypothetical site resident scenario.

Hypothetical Site Workers (Current Land Use)

No risk or hazard-based COCs were identified for the hypothetical site worker scenario.

Groundwater

Hypothetical Site Residents (Future Land Use)

Beryllium was identified as a COC for this scenario based on its contribution to risk/hazard.

Hypothetical Site Workers (future land use)

Beryllium was identified as a COC for this scenario based on its contribution to risk/hazard.

Due to the limited extent of identified shallow groundwater impacts, graphical presentation of risk projections for SWMU 13 groundwater was determined to be of limited use. Instead, the extent of the COC is briefly discussed below. Beryllium was detected in one second-quarter shallow groundwater sample. The third- and fourth-quarter results will confirm whether beryllium is present in shallow groundwater. This review will facilitate responsible and sound risk management decisions.

6.2.2.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site groundwater, and they are infrequently exposed to surface soil when walking across exposed soil at the site. Approximately 90% of the site is paved. Firefighter trainees would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year, as assumed in the exposure assessment, and the duration of training activities is much less than 25 years. Using the site for training drills 52 days per year would reduce exposure frequency 80% relative to the default site worker assumptions. In addition, less than eight hours per day are required to complete training drills. As a result, estimated exposure would be proportionately reduced.

Residential use of the site would not be expected, based on current site uses and the nature of the surrounding buildings. SWMU 13 is a firefighting training area. Current base reuse plans call for a cargo terminal. If this area were to be used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at SWMU 13 for potable or industrial purposes. A basewide system supplies drinking and process water to Zone H buildings. This system is to remain in operation under the current base reuse plan. As a result, shallow groundwater use would not be expected under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Based on the guidance provided by USEPA and discussed in Section 6.1.4.4 of this report, EPCs are used to estimate CDI. The uncertainty associated with EPCs primarily stems from their statistical determination (UCLs) or imposition of maximum concentrations.

Soil

BEQs reportedly exceeded the residential RBC at three sample locations: 013SB005, 013SB008, and 013SB017. Likewise, heptachlor concentrations reportedly exceeded the residential RBC at two sample locations, 013SB006 and 013SB019. EPCs at these locations are underestimates relative to the UCL. The UCL was calculated assuming sitewide exposure, as the data do not clearly define a hot spot.

Groundwater

Beryllium exposure was estimated using the maximum reported concentration, and therefore, risk is calculated based on the maximum reported concentration is likely an overestimate.

Frequency of Detection and Spatial Distribution

BEQs and heptachlor were detected in three of 23 and two of 23 surface soil samples analyzed for these compounds, respectively. The limited frequency of detection suggests that the compounds are not widespread at SWMU 13. BAP accounted for approximately 80% of the equivalent concentrations, and PAHs were reported in only three of 23 samples. By imposing the UCL, RME was estimated for this site. If the fraction ingested from contaminated source (based on the frequency of detection for each COPC) were considered in the exposure calculations at this site, the risk estimates for surface soil and groundwater would be significantly less. However, based on the distribution of the reported concentrations, no hot spot was clearly evident, and hot spot analysis was not performed.

TPH results reported in site soil (75 to 730 mg/kg) exceeded the NAVBASE soil threshold of 100 mg/kg. No groundwater sample contained detectable concentrations of TPH. The absence of TPH in groundwater indicates the shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of TPH constituents.

Beryllium was reported in only one of nine second-quarter groundwater samples analyzed, and the maximum concentration was used to estimate exposure. Imposing the maximum reported concentration overestimates exposure because low detection frequency compounds are not distributed equally across the site.

Quantification of Risk/Hazard

As indicated by the discussions above, uncertainty is inherent during the risk assessment process. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of variability and uncertainty are discussed below.

Soil

Of the CPSSs eliminated from formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Concentrations of aluminum, arsenic, beryllium, and manganese exceed their corresponding RBCs, but none of the maximum concentrations exceeds the corresponding reference concentration. Therefore, they were eliminated from formal assessment based on comparisons to the reference concentrations because they do not contribute to excess risk/hazard onsite.

Although future land use at this site is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely overestimate risk and/or hazard.

Groundwater

No COPCs were identified for this exposure pathway based on the first-quarter screening comparisons. However, 2-methylnaphthalene and beryllium were identified as COPCs based on second-quarter groundwater sampling. Of the CPSSs eliminated from formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration close to its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Manganese and arsenic concentrations exceed the corresponding RBCs, but these elements do not exceed the corresponding reference concentrations. Therefore, manganese and arsenic were eliminated from formal assessment based on comparison to the corresponding reference concentrations because they do not contribute to excess risk/hazard onsite.

As a measure of variability, CT analysis was performed for soil and groundwater. Exposure assumptions were modified to reflect the 50th percentile rather than the 95th, and EPCs were not modified. In accordance with *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure-Draft* (USEPA, November 1993), the exposure duration of site residents were reduced from 30 to nine years, two years for child exposure, and seven years for adult exposure. Exposure frequency was reduced from 350 to 234 for site residents and from 250 to 219 for site workers. The drinking water ingestion rate for an adult was reduced from 2 to 1.4 liters per day, and exposure to groundwater was reduced by 25% to account for other water sources. Based on CT, the shallow groundwater-related risk (incidental ingestion) would be approximately 2E-6, and the CT estimate for the worker would be 6E-7. HI estimates are below 1.0. Tables 6.2.2.16 and 6.2.2.17 present the CT CDI and risk/hazard for the ingestion of groundwater exposure pathway, respectively.

6.2.2.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 13 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion was evaluated for shallow groundwater based on first- and second-quarter groundwater monitoring data. Table 6.2.2.18 summarizes the risk summary for each pathway/receptor group evaluated for SWMU 13.

6.2.2.8 Remedial Goal Options

Soil

No COCs were identified for soil exposure pathways, and therefore, no RGOs were calculated.

Groundwater

RGOs were calculated for ingestion of shallow groundwater. RGOs calculated for the site resident and site worker are presented in Tables 6.2.2.19 and 6.2.2.20, respectively.

Table 6.2.2.1
Methods Run at SWMU 13
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Harb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
013	B001	S	S	S	Y					S	Y					
013	B002	S	S	S	Y					S	Y					
013	B003	S	S	S	Y					S	Y					
013	B004	S	S	S	Y					S	Y					
013	B005	S	S	S	Y					S	Y					
013	B006	B	B	B	Y	Y	Y	Y	A	B	B					
013	B007	S	S	S	Y					S	Y					
013	B008	S	S	S	Y					S	Y					
013	B009	S	S	S	Y					S	Y					
013	B010	S	S	S	Y					S	Y					
013	B011	S	S	S	Y					S	Y					
013	B012	S	S	S	Y					S	Y					
013	B013	S	S	S	Y					S	Y					
013	B014	S	S	S	Y					S	Y					
013	B015	S	S	S	Y					S	Y					
013	B016	S	S	S	Y					S	Y					
013	B017	S	S	S	Y					S	Y					
013	B018	S	S	S	Y					S	Y					
013	B019	S	S	S	Y					S	Y					
013	B020	S	S	S	Y					S	Y					
013	B021	B	B	B	Y	Y	Y	Y	A	B	B					
013	B022	B	B	B	Y	Y	Y	Y	A	B	B					
013	B023	S	S	S	Y					S	Y					
013	B024						Y									
013	B025						Y									
013	B026						Y									
013	B027						Y									
013	B028						Y									
013	B18A													Y	Y	Y
013	B19A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
		Tph:	Total Petroleum Hydrocarbons: Method 418.1
VOA:	Volatile Organics: Method 8240	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
SVOA:	Semi-volatile Organics: Method 8270		
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.2.2
Methods Run at SWMU 13
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
013	1301	S	S	S	Y					S	Y					
013	1302	S	S	S	Y					S	Y					
013	W001	S	S	S	Y					S	Y					
013	W002	S	S	S	Y					S	Y					
013	W003	S	S	S	Y					S	Y					
013	W004	S	S	S	Y					S	Y					
013	W005	S	S	S	Y					S	Y					
013	W006	S	S	S	Y					S	Y					
013	W007	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.2.3
Methods Run at SWMU 13
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
013	1301	S	S							S						
013	1302	S	S							S						
013	W001	S	S							S						
013	W002	S	S							S						
013	W003	S	S							S						
013	W004	S	S							S						
013	W005	S	S							S						
013	W006	S	S							S						
013	W007	S	S							S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.2.4
SWMU 13
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	18/ 23	18.80 - 29.00	25.000 - 190.000	89.888	780000.0000			
Aluminum	MG/KG	23/ 23		554.000 - 11300.000	3270.782	7800.0000	1	25310.000	
Antimony	MG/KG	1/ 23	0.98 - 14.30	1.900 - 1.900	1.900	3.1000			
Arsenic	MG/KG	11/ 23	0.96 - 6.00	1.600 - 5.600	3.495	0.3700	11	14.810	
beta-BHC	UG/KG	2/ 23	1.70 - 40.00	1.500 - 19.500	10.500	350.0000			
alpha-BHC	UG/KG	1/ 23	1.70 - 40.00	1.000 - 1.000	1.000	100.0000			
Barium	MG/KG	10/ 23	0.99 - 21.90	1.900 - 36.400	13.845	550.0000		40.330	
* Benzo(a)pyrene Equivalents	UG/KG	23/ 23		54.725 - 122.090	60.277	88.0000	2		
Benzo(a)anthracene	UG/KG	2/ 23	330.00 - 540.00	110.000 - 120.000	115.000				
Benzo(b)fluoranthene	UG/KG	3/ 23	330.00 - 540.00	65.000 - 130.000	94.666				
Chrysene	UG/KG	2/ 23	46.00 - 540.00	110.000 - 140.000	125.000				
Benzo(k)fluoranthene	UG/KG	2/ 23	330.00 - 540.00	84.000 - 95.000	89.500				
Benzo(a)pyrene	UG/KG	2/ 23	330.00 - 540.00	91.000 - 96.000	93.500				
Beryllium	MG/KG	4/ 23	0.10 - 1.30	0.180 - 0.670	0.328	0.1500	4	1.470	
2-Butanone (MEK)	UG/KG	2/ 23	10.00 - 50.00	13.000 - 23.000	18.000	4700000.0000			
Cadmium	MG/KG	3/ 23	0.14 - 1.80	0.160 - 0.190	0.176	3.9000		1.050	
Calcium	MG/KG	23/ 23		3000.000 - 312000.000	29293.478				
alpha-Chlordane	UG/KG	5/ 23	1.70 - 40.00	1.400 - 69.000	19.120	470.0000			
gamma-Chlordane	UG/KG	5/ 23	1.70 - 40.00	1.500 - 160.000	42.580	470.0000			
Chromium	MG/KG	23/ 23		2.700 - 19.700	10.189	39.0000		85.650	
Cobalt	MG/KG	7/ 23	0.59 - 4.90	0.825 - 3.300	1.525	470.0000		5.860	
Copper	MG/KG	14/ 23	0.25 - 5.90	1.700 - 49.900	12.682	290.0000		27.600	1
Cyanide	MG/KG	2/ 23	0.80 - 1.00	1.000 - 5.500	3.250	160.0000			
4,4'-DDD	UG/KG	5/ 23	3.30 - 40.00	5.000 - 250.000	57.820	2700.0000			
4,4'-DDE	UG/KG	18/ 23	3.70 - 5.00	3.000 - 380.000	42.862	1900.0000			
4,4'-DDT	UG/KG	4/ 23	3.30 - 40.00	7.000 - 152.500	58.625	1900.0000			
Di-n-butylphthalate	UG/KG	1/ 23	330.00 - 540.00	180.000 - 180.000	180.000	780000.0000			
Diethylphthalate	UG/KG	1/ 23	330.00 - 540.00	56.000 - 56.000	56.000	6300000.0000			
Dioxin (TCDD TEQ)	PG/G	8/ 8		1.029 - 427.720	69.278	1000.0000			
Endosulfan II	UG/KG	1/ 23	3.30 - 80.00	5.100 - 5.100	5.100	47000.0000			
Endrin aldehyde	UG/KG	1/ 23	3.30 - 80.00	3.400 - 3.400	3.400	2300.0000			
Fluoranthene	UG/KG	4/ 23	330.00 - 540.00	47.000 - 290.000	156.750	310000.0000			
* Heptachlor	UG/KG	2/ 23	1.70 - 40.00	5.300 - 390.000	197.650	140.0000	1		
Heptachlor epoxide	UG/KG	5/ 23	1.70 - 40.00	4.000 - 23.000	12.140	70.0000			

Table 6.2.2.4
SWMU 13
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Hexachlorocyclopentadiene	UG/KG	1/ 23	330.00 - 540.00	430.000 - 430.000	430.000	55000.0000			
Iron	MG/KG	23/ 23		1550.000 - 16400.000	5344.782			30910.000	
Lead	MG/KG	12/ 23	2.00 - 23.10	5.900 - 84.700	31.100	400.0000j		118.000	
Magnesium	MG/KG	23/ 23		213.000 - 2780.000	921.391			9592.000	
Manganese	MG/KG	23/ 23		21.900 - 218.000	76.152	39.0000	21	636.400	
Mercury	MG/KG	4/ 23	0.02 - 0.04	0.030 - 0.080	0.052	2.3000		0.490	
Nickel	MG/KG	9/ 23	0.76 - 7.70	1.400 - 22.100	6.938	160.0000		33.380	
Phenanthrene	UG/KG	3/ 23	330.00 - 540.00	130.000 - 240.000	166.666	310000.0000k			
Potassium	MG/KG	5/ 23	132.00 - 689.00	180.000 - 1040.000	543.800				
Pyrene	UG/KG	5/ 23	330.00 - 540.00	55.000 - 230.000	117.600	230000.0000			
Selenium	MG/KG	1/ 23	0.06 - 2.40	0.600 - 0.600	0.600	39.0000		2.000	
Sodium	MG/KG	22/ 23	47.10 - 47.10	61.900 - 414.000	154.681				
2,4,5-T	UG/KG	1/ 3	10.00 - 10.00	7.700 - 7.700	7.700	78000.0000			
2,4,5-TP (Silvex)	UG/KG	2/ 3	10.00 - 10.00	6.900 - 8.600	7.750	63000.0000			
* Petroleum Hydrocarbons, TPH	MG/KG	10/ 23	62.00 - 90.00	75.000 - 730.000	214.800	10.0000	10		
Toluene	UG/KG	8/ 23	3.60 - 10.00	3.000 - 5.000	3.700	1600000.0000			
Vanadium	MG/KG	22/ 23	3.10 - 3.10	4.450 - 30.400	11.913	55.0000		77.380	
Zinc	MG/KG	14/ 23	8.00 - 29.90	11.250 - 269.000	64.425	2300.0000		214.300	1

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- h Endrin used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.2.5
SWMU 13
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/L	1/ 9	11.00 - 11.00	2.400 - 2.400	2.400	220.0000			
Aluminum	UG/L	1/ 9	14.00 - 66.80	755.000 - 755.000	755.000	3700.0000			
Arsenic	UG/L	1/ 9	3.80 - 7.70	12.100 - 12.100	12.100	0.0380	1	27.990	
Butylbenzylphthalate	UG/L	1/ 9	11.00 - 11.00	2.300 - 2.300	2.300	730.0000			
Calcium	UG/L	9/ 9		79300.000 - 148000.000	103344.444				
4,4'-DDT	UG/L	1/ 9	0.10 - 0.10	0.100 - 0.100	0.100	0.2000			
Iron	UG/L	8/ 9	13.90 - 13.90	188.000 - 4120.000	1702.875				
Magnesium	UG/L	9/ 9		3680.000 - 78700.000	23457.777				
Manganese	UG/L	9/ 9		12.000 - 925.000	282.844	18.0000	8	3391.000	
Phenanthrene	UG/L	1/ 9	11.00 - 11.00	3.600 - 3.600	3.600	150.0000k			
Potassium	UG/L	9/ 9		2940.000 - 59800.000	24348.888				
Sodium	UG/L	9/ 9		5140.000 - 318000.000	94415.555				
Vanadium	UG/L	1/ 9	3.10 - 5.30	13.600 - 13.600	13.600	26.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- k Fluoranthene used as surrogate

Table 6.2.2.6
SWMU 13
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/L	1/ 9	11.00 -	46.00	2.500 -	2.500	2.500	220.0000			
Aluminum	UG/L	2/ 9	15.40 -	15.40	22.100 -	166.000	94.050	3700.0000			
Arsenic	UG/L	3/ 9	2.60 -	2.60	4.100 -	7.400	5.466	0.0380	3	27.990	
Barium	UG/L	8/ 9	0.80 -	0.80	1.100 -	20.400	7.425	260.0000		323.000	
* Beryllium	UG/L	1/ 9	0.20 -	0.20	0.210 -	0.210	0.210	0.0160	1		
Calcium	UG/L	9/ 9			41200.000 -	136000.000	104677.777				
Cobalt	UG/L	1/ 9	2.40 -	2.40	3.600 -	3.600	3.600	220.0000			
Fluorene	UG/L	1/ 9	11.00 -	46.00	3.800 -	3.800	3.800	150.0000			
Iron	UG/L	9/ 9			95.000 -	5780.000	2289.333				
Magnesium	UG/L	9/ 9			5590.000 -	66700.000	23890.000				
Manganese	UG/L	9/ 9			51.300 -	862.000	313.944	18.0000	9	3391.000	
2-Methylnaphthalene	UG/L	1/ 9	11.00 -	46.00	3.000 -	3.000	3.000	150.0000i			
Potassium	UG/L	9/ 9			7570.000 -	63500.000	24324.444				
Selenium	UG/L	3/ 9	3.50 -	3.50	3.300 -	5.400	4.066	18.0000		3.150	3
Sodium	UG/L	9/ 9			14300.000 -	370000.000	113922.222				
Zinc	UG/L	2/ 9	6.30 -	15.70	10.600 -	20.400	15.500	1100.0000			

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

i Naphthalene used as surrogate

Table 6.2.2.7
Exposure Pathways Summary — SWMU 13
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Site User (Firefighter Trainees and Instructors)	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were reported in surface soils, and portions of the site area is paved/covered by buildings.
	Air, Inhalation of chemicals entrained in fugitive dust	No	A significant portion of the site area is paved/covered by buildings. The remaining soils are covered by vegetation which would be expected to minimize any fugitive dust emissions onsite.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 13.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 13.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were reported in surface soils, and a significant portion of the site area is paved/covered by buildings.
	Air, Inhalation of chemicals entrained in fugitive dust	No	A significant portion of the site area is paved/covered by buildings. The remaining soils are covered by vegetation which would be expected to minimize any fugitive dust emissions onsite.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater COPCs were identified subsequent to risk-based and background screening of maximum shallow groundwater concentrations.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Shallow groundwater COPCs were identified subsequent to risk-based and background screening of maximum shallow groundwater concentrations.

Table 6.2.2.7
Exposure Pathways Summary — SWMU 13
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the future site worker and hypothetical residential scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the future site worker and hypothetical residential scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.2.8
Statistical Analysis of COPCs
Surface Soils at SWMU 13
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed SD	Mean	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Benzo(a)pyrene Equivalents	23	0.22	4.07	1.777	0.065	0.122	0.065	UCL used	1	0.065
Heptachlor	23	1.24	0.99	2.872	0.012	0.39	0.012	UCL used	NA	0.012

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.2.9
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.065	8.93E-08	8.34E-07	1.02E-07	3.19E-08	1.14E-08
Heptachlor	NA	0.012	1.70E-08	1.59E-07	1.94E-08	6.07E-09	2.17E-09

NOTES:

lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk

Table 6.2.2.10
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.065	0.01	3.66E-08	1.21E-07	2.29E-08	2.62E-08	9.34E-09
Heptachlor	NA	0.012	0.01	6.97E-09	2.30E-08	4.36E-09	4.98E-09	1.78E-09

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.2.11
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Beryllium	0.00021	5.75E-06	1.34E-05	3.16E-06	2.14E-06	1.05E-06

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

le 6.2.2.12 - SWMU 13
icological Database Information
Chemicals of Potential Concern
/BASE Charleston, Zone H

	Non-Carcinogenic Toxicity Data								
mical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation
yllium	0.005	a	L	microscopic organ changes	100	ND			ND
zo(a)pyrene Equivalents	ND				ND	ND			ND
tachlor	0.0005	a	L	liver weight increase	300	ND			ND
ethylnaphthalene	0.04	f							

NOTES:

a Integrated Risk Information System (IRIS)
e EPA Environmental Criteria and Assessment Office - Cincinnati (provisional)
f Withdrawn from IRIS or HEAST
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

able 6.2.2.12 - SWMU 13
oxicological Database Information
r Chemicals of Potential Concern
AVBASE Charleston, Zone H

	Carcinogenic Toxicity Data					
	Oral Slope Factor		Inhalation Slope Factor		Weight of	Tumor
hemical	[(mg/kg/day)]-1		[(mg/kg/day)]-1		Evidence	Type
eryllium	4.3	a	8.4	a	B2	osteosarcoma
enzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
eptachlor	4.5	a	ND		B2	liver tumors
Methylnaphthalene						

Table 6.2.2.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	7.5E-07	ND	8.3E-08
Heptachlor	0.0005	4.5	0.000034	0.00032	8.7E-08	0.000012	9.8E-09
SUM Hazard Index/ILCR			0.000034	0.00032	8E-07	0.000012	9E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.2.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	3.3E-07	ND	1.4E-07
Heptachlor	0.5	0.00025	9	0.000028	0.000092	3.9E-08	0.000020	1.6E-08
SUM Hazard Index/ILCR				0.000028	0.000092	4E-07	0.000020	2E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.2.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Beryllium	0.005	4.3	0.0012	0.0027	1.4E-05	0.00043	4.5E-06
SUM Hazard Index/ILCR			0.001	0.003	1E-05	0.0004	5E-06

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk

Table 6.2.2.16
Central Tendency Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Beryllium	0.00021	2.02E-06	6.73E-06	4.04E-07	1.35E-06	1.33E-07

NOTES:

lwa	lifetime weighted average
CDI	Chronic Daily Intake
H-CDI	Non-carcinogenic hazard based Chronic Daily Intake
C-CDI	Carcinogenic risk based Chronic Daily Intake

Table 6.2.2.17
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Beryllium	0.005	4.3	0.00040	0.0013	1.7E-06	0.00027	5.7E-07
SUM Hazard Index/ILCR			0.0004	0.001	2E-06	0.0003	6E-07

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk

Table 6.2.2.18
Summary of Risk and Hazard for SWMU 13
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.00003	0.00032	8E-07	0.00001	9E-08
	Dermal Contact	0.00003	0.00009	4E-07	0.00002	2E-07
Shallow Groundwater	Ingestion	0.001	0.003	1E-05	0.0004	5E-06
Sum of All Pathways		0.001	0.003	1E-05	0.0005	5E-06

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

ɔle 6.2.2.19
sidential-Based Remedial Goal Options
val Base Charleston, SWMU 13 Shallow Groundwater
ıarleston, South Carolina

				Hazard-Based Remedial Goal Options			**Risk-Based Remedial Goal Options**				
ıemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	**0.1** mg/l	**1.0** mg/l	**10** mg/l	**1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	Background Concentration mg/l
ːryllium	4.3	0.005	0.00021	0.0078	0.078	0.78	0.000015	0.00015	0.0015	0.004	ND
Methylnaphthalene	NA	NA	0.003	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

able 6.2.2.20
Vorker-Based Remedial Goal Options
aval Base Charleston, SWMU 13 Shallow Groundwater
harleston, South Carolina

hemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	**Hazard-Based Remedial Goal Options** **0.1** mg/l	**1.0** mg/l	**10** mg/l	**Risk-Based Remedial Goal Options** **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	Background Concentration mg/l
eryllium	4.3	0.005	0.00021	0.049	0.49	4.91	0.000046	0.00046	0.0046	0.004	ND
-Methylnaphthalene	NA	NA	0.003	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

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5.5 SWMU 14 (Includes SWMU 15 and AOCs 670 and 684)

SWMU 14 is a flat, open, vegetated site which served as a chemical disposal area for miscellaneous chemicals, warfare decontaminating agents, and possibly industrial wastes. A small drainage ditch originates in SWMU 14 and runs southeast toward the dredged material area. This ditch has a very low gradient and the direction of surface water flow within it is not apparent. Surface soil, subsurface soil, groundwater, and surface water samples were collected from SWMU 14. Sediment samples were collected from the ditch within the site.

SWMU 15 and AOC 670 and AOC 684 are within the SWMU 14 boundary. SWMU 15, on the northwest corner of SWMU 14, is the site of a former propane-fired incinerator used to destroy classified documents. AOC 670, formerly a trap and skeet range, and AOC 684, formerly an outdoor pistol range, are separated by a ditch which runs east and west through the center of SWMU 14. Surface and subsurface soil were sampled from these sites and sediment samples were analyzed for AOCs 670 and 684. The evaluation of contaminant transfer from soil to groundwater was based on a comparison of the soil data from these SWMUs/AOCs and the shallow groundwater data from overall SWMU 14.

Potential migration pathways for SWMU 14, include constituents leaching from soil to groundwater, migrating from groundwater to surface water, and volatilizing from surface soil to air. Constituent transport by sediment and/or surface water movement is also a possible migration pathway in the SWMU 14 area; however, site drainage features do not appear to have definite outlets. Therefore, minimal migration is expected through this pathway. Potential correlation between surface soil and sediment impacts were addressed through qualitative and semiquantitative screening analysis. Potential receptors to contaminants migrating from the SWMU 14 area would likely involve the wetland area adjacent to SWMU 14. This subject is addressed in Section 7.

5.5.1 SWMU 14 — Soil-to-Groundwater Cross-Media Transport

Table 5.5.1 compares the maximum detected concentration in SWMU 14, SWMU 15, AOC 670, and AOC 684 soils to the groundwater protection risk-based SSLs or the soil background UTLs. Additional notations are made for those constituents detected in overall SWMU 14 shallow groundwater and those which exceeded the risk-based screening criteria for tap water or the shallow groundwater background UTLs. Two contaminants (chromium and lead) are highlighted as soil to groundwater migration concerns based on their presence in both soil and shallow groundwater in excess of RBCs, SSLs, and background UTLs. Based on the physical and chemical parameters of SWMUs 14, and 15, and AOCs 670 and 684 soils, the high levels of dissolved salts in the groundwater, and the neutral-to-high pH, chromium and lead will tend to precipitate and bind to soil particles rather than dissolve and travel in groundwater.

Constituents detected in SWMU 14 soil above the groundwater protection SSLs or background UTLs include chromium, copper, lead, selenium, and 1,2,3-trichloropropane. Chromium, copper, and selenium exceeded the background UTLs in one (chromium and copper) or two (selenium) samples such that these constituents do not indicate a widespread deviation from background. Chromium was detected in overall SWMU 14 groundwater above the tap water RBC for hexavalent chromium, and selenium was detected in overall SWMU 14 groundwater above the background UTL. Chromium, copper, and selenium were not detected in monitoring well NBCH014002 located nearest to SWMU 14; rather, these detections occurred in a monitoring wells positioned upgradient of SWMU 14. These findings indicate that SWMU 14 soil concentrations of chromium and selenium are not likely to threaten the shallow aquifer. 1,2,3-Trichloropropane exceeded the SSL in only one surface soil sample and was not detected in the subsurface soil. Considering the limited source and its absence from subsurface soil, 1,2,3-trichloropropane is not likely to threaten the shallow aquifer. Lead exceeded the background UTL in several samples; however, it did not exceed the background UTL in subsurface soil or the action level in overall SWMU 14 groundwater. The soil to groundwater migration pathway for lead currently is not impacting shallow groundwater above the action level.

Constituents detected in SWMU 15 soil above the groundwater protection SSLs or background UTLs include arsenic, alpha-BHC, copper, and dieldrin. Arsenic and copper were detected above their background UTLs infrequently in SWMU 15 soil. Arsenic did not exceed background UTL and copper was not detected in overall SWMU 14 groundwater. As a result, SWMU 15 soil concentrations of arsenic and copper are not likely to threaten the shallow aquifer. Dieldrin and alpha-BHC were detected above the groundwater protection SSLs in 1 of 4 surface soil samples and were not detected in the subsurface soil. Dieldrin and alpha-BHC were not detected in overall SWMU 14 groundwater. Considering the limited extent of contamination and the lack of presence in groundwater, SWMU 15 soil concentrations of dieldrin and alpha-BHC are not likely to threaten the shallow aquifer.

Constituents detected in AOC 670 soil above the groundwater protection SSLs or background UTL include arsenic, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dieldrin, lead, methylene chloride, selenium, and thallium. Dieldrin was detected in 1 of 28 surface soil samples and was not detected in the subsurface soil or shallow groundwater. Considering the limited extent of dieldrin contamination, impacts to the shallow aquifer are not likely. Monitoring well NBCH014001, near AOC 670, exhibited lead concentrations of 19.7 μg/L which is marginally above the USEPA treatment technique AL for lead 15 μg/L. These findings indicate that soil lead concentrations may be impacting the shallow aquifer. Benzo(a)pyrene equivalent (BEQ) compounds (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene) were detected in AOC 670 surface soil at concentrations above the groundwater protection SSL in 5 of 34 samples. BEQ compounds were detected in 4 of 32 subsurface soil samples at concentrations below the groundwater protection SSL and were not detected in overall SWMU 14 shallow groundwater. Although conservative screening indicates that BEQ compounds have the potential for isolated leaching to groundwater, the limited impact to subsurface soil and absence from shallow groundwater suggest that this migration pathway is insignificant for AOC 670. Arsenic, selenium, and thallium were detected in only one soil sample above the background UTLs (arsenic and thallium) or groundwater protection SSLs (selenium). The limited soil impacts of arsenic, selenium, and thallium do not indicate a significant threat to the shallow aquifer. Methylene chloride was detected in 10 of 28 surface soil and 10 of 27 subsurface soil samples in excess of the groundwater protection SSL. Methylene chloride was not, however, detected in overall SWMU 14 shallow groundwater. Although conservative screening indicates that methylene chloride has the potential for impacts to SWMU 14 groundwater, widespread impacts have not currently been shown. It should be noted that methylene chloride is a common laboratory contaminant and was present in blanks associated with the overall SWMU 14 investigation. This adds some uncertainty to conclusions drawn regarding methylene chloride soil to groundwater migration.

Barium, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, chlorobenzilate, copper, dieldrin, 7,12-dimethylbenz(a)anthracene, methylene chloride, and thallium were detected in AOC 684 soil at concentrations above the groundwater protection SSLs or background UTLs. None of these constituents was detected in overall SWMU 14 groundwater, indicating that their soil concentrations are protective of the shallow aquifer. Chlorobenzilate, dieldrin, and 7,12-dimethylbenz(a)anthracene were detected in surface soil in one (7,12-dimethylbenz(a)anthracene) or 3 (chlorobenzilate and dieldrin) samples and were not detected in subsurface soil. Considering the limited extent of soil impacts, chlorobenzilate, dieldrin, and 7,12-dimethylbenz(a)anthracene soil concentrations are not likely to impact the shallow aquifer. BEQ compounds (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene) were detected above the groundwater protection SSL in 12 of 44 surface soil samples. BEQ compounds were detected in only 3 of 30 subsurface soil samples, all at concentrations below the groundwater protection SSL. Although conservative screening indicates that BEQ compounds have the potential to impact the SWMU 14 groundwater, the limited impacts to subsurface soil and their absence from overall SWMU 14 groundwater suggest that this migration is not a significant process for AOC 684. Methylene chloride was detected in 3 of 32 surface soil and 2 of 22 subsurface soil samples in excess of the groundwater protection SSL. Although conservative screening indicates that methylene chloride has the potential for isolated impacts to SWMU 14 groundwater, widespread impacts are not expected. It should be noted that methylene chloride is a common laboratory contaminant and was present in blanks associated with the overall SWMU 14 investigation. This adds some uncertainty to conclusions drawn regarding methylene chloride soil to groundwater migration.

5.5.2 SWMU 14 — Groundwater-to-Surface Water Cross-Media Transport

Table 5.5.2 summarizes the groundwater-to-surface water transfer screening process. Of the constituents detected in both groundwater and surface water, arsenic, chlorinated dibenzodioxins/dibenzofurans and lead exceed the saltwater chronic WQC. The qualitative screening process identified one additional contaminant (chromium), detected in groundwater only, which has a published WQC protective of aquatic life. Additional quantitative screening identified five constituents (aluminum, chromium, chlorinated dibenzodioxins/dibenzofurans, lead, and vanadium) which were detected in groundwater above their tap water RBCs or grid-based background UTLs. The chlorinated herbicide DCAA, detected in SWMU 14 groundwater, could not be screened as described in Section 5.2 due to the absence of soil and surface water data with which to perform the qualitative screening, and the absence of toxicity criteria with which to develop risk-based concentrations to perform the quantitative screening.

Aluminum, chromium, lead, and vanadium were all found to exceed their respective tap water RBCs or background UTLs in one monitoring well (NBCH014001) during the second-quarter sampling event. These findings indicate an isolated area of inorganic contamination with little evidence supporting groundwater transport of these chemicals. Chlorinated dibenzodioxins/dibenzofurans were detected above the tap water RBC in all SWMU 14 monitoring wells; however, the high K_{oc} value estimated for these compounds indicates they tend to sorb to soil particles and are not likely to migrate in groundwater.

The surface water sample for combined SWMU 14 was collected from a ditch that divides AOCs 670 and 684. Contaminant concentrations present in water that collects in this ditch may in part be due to the erosion of surface soil, forming contaminated sediments. Based on their chemical characteristics, chlorinated dibenzodioxins/dibenzofurans detected in surface water were likely associated with suspended sediment. In this state, surface water transport is a viable migration pathway. With no apparent discharge point associated with the drainage feature, further migration of the contaminated sediment cannot be predicted. Although arsenic and lead concentrations exceed saltwater chronic WQC, their presence in surface water is not unexpected under natural conditions. Qualitative commonalities with respect to inorganic parameters are not in themselves definitive evidence of a link between shallow groundwater impacts and surface water quality. Evaluation of empirical data for combined SWMU 14 groundwater and surface water in conjunction with what is known of SWMU 14 topography indicates that deposition of contaminated sediments, rather than contaminated groundwater migration, may be more significant relative to concentrations of contaminants present in SWMU 14 surface water. Surface soil to sediment contaminant transfer is addressed in Section 5.5.4.

Based on the isolated nature of the contamination in combined SWMU 14, groundwater contaminant migration does not appear be significant via this mechanism. Aside from the small drainage feature, the nearest surface water body to SWMU 14 is the Cooper River. Estimated groundwater travel times from each of the SWMUs/AOCs to the Cooper River range from 230 years (AOC 684) to 378 years (SWMU 14). In addition, the capacity for soil to retard the movement of contaminants in the aquifer, the lack of empirical evidence in support of contaminants migrating in groundwater, and expected dilutional effects upon transport through the vadose zone combine to make constituent transfer to the Cooper River, via groundwater, unlikely. The Zone J RFI will provide additional data with which to evaluate the groundwater-to-surface water contaminant migration pathway.

5.5.3 SWMU 14 — Soil-to-Air Cross-Media Transport

Table 5.5.3 lists the VOCs detected in surface soil samples collected at SWMU 14 along with corresponding soil-to-air volatilization screening levels. The maximum surface soil concentration of 1,2,3-trichloropropane exceeded its corresponding soil-to-air volatilization screening level (0.0912 mg/kg reported vs. 3E-5 mg/kg screening level). A conservative soil-to-air screening value of 10,000 mg/kg was used for 2-butanone.

1,2,3-Trichloropropane was detected in one of nine surface soil samples at SWMU 14. Under the soil-to-air screening model, the screening level was derived to represent the acceptable mean concentration on a 30-acre site. This approach assumes that a homogeneous source exists which can consistently emit 1,2,3-trichloropropane at a rate that will result in unacceptable ambient air concentrations. The limited extent of soil impacts reported at SWMU 14 indicates that the source amount onsite is far less than that assumed in the screening level development model. Based on available data, significant 1,2,3-trichloropropane concentrations would not be expected in ambient air, although it cannot be definitively concluded that ambient air quality would not be detrimentally affected. Limited supplemental soil and/or air sampling during the CMS would assist in determining whether 1,2,3-trichloropropane concentrations are actionable relative to ambient air quality considerations.

5.5.4 SWMU 14 — Soil-to-Sediment Cross-Media Transport

Table 5.5.4 summarizes the screening for the surface soil to sediment contaminant transfer process. Contaminants found in both the surface soil and sediment samples collected from AOCs 670 and 684 include three VOCs (methylene chloride, toluene, and xylene), 10 SVOCs (acenaphthene, anthracene, benzo[g,h,i]perylene, benzo[a]pyrene equivalents, dibenzofuran, bis[2-ethylhexyl]phthalate, fluoranthene, fluorene, phenanthrene and pyrene), eight pesticides (alpha-chlordane, gamma-chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, endosulfan II, endrin, and endrin aldehyde), chlorinated dibenzodioxins/dibenzofurans, two chlorinated herbicides (2,4-D and 2,4,5-T) and 12 inorganics (arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, vanadium, and zinc). Of these contaminants 4,4'-DDD was present in sediment at concentrations significantly higher than the surface soil concentration. Vinyl chloride was detected in sediment only and cannot be directly related to surface soil transport. Except for 4,4'-DDD, contaminant concentrations in sediment were approximately equal to concentrations in soil, suggesting the potential for erosion of surface soil resulting in the formation of a depositional zone within the drainage feature. With no apparent outlet from the drainage feature from which the SWMU 14 sediment samples were collected, further migration of sediments beyond SWMU 14 cannot be predicted. Potential ecological impacts of contaminated sediments are addressed in Section 7.

5.5.5 SWMU 14 — Fate and Transport Summary

Table 5.5.5 lists all the contaminants that have been found to be significant in terms of fate and transport with a notation of the significant migration pathways for each contaminant.

Table 5.5.1
Chemicals Detected in Soil for SWMUs 14, 15, and AOCs 670 and 684
Soil to Groundwater Screening Analysis
NAVBASE-Charleston, Zone H, SWMUs 14, 15 and AOCs 670, 684

Parameter		SWMU 14 Surface Soil	SWMU 14 Subsurface Soil	SWMU 15 Surface Soil	SWMU 15 Subsurface Soil	AOC 670 Surface Soil	AOC 670 Subsurface Soil	AOC 684 Surface Soil	AOC 684 Subsurface Soil	Ground-water Protection SSL	Detected in Ground water
Acenaphthene	ug/kg	130	ND	190	ND	3145	ND	2800	ND	20000	
Acenaphthylene	ug/kg	ND	ND	ND	ND	ND	ND	286	ND	20000	
Acetone	ug/kg	ND	ND	69	91	78	200	97.4	284	800	
Acetonitrile	ug/kg	ND	ND	ND	ND	ND	7.3	ND	6.6	70	
Aldrin	ug/kg	ND	ND	ND	ND	1.7	ND	ND	ND	5	
Aluminum	mg/kg	29600	ND	16500	17600	21700	31200	ND	ND	46180	II (x)
Anthracene	ug/kg	190	ND	182	ND	4495	37.2	4400	ND	430000	
Antimony	mg/kg	2	ND	ND	ND	11.4	2.7	12.4	8.7	NDA	
Aroclor-1254	ug/kg	ND	ND	ND	ND	ND	ND	160	ND	8200	
Aroclor-1260	ug/kg	ND	ND	ND	ND	ND	ND	376	ND	8200	
Arsenic	mg/kg	13.6	ND	53.1	13.4 *	69	29.4 *	16.3	17.8	35.52	I
beta-BHC	ug/kg	ND	ND	ND	ND	ND	ND	ND	2	2	
alpha-BHC	ug/kg	ND	ND	1.4	ND *	ND	ND	ND	ND	0.4	
delta-BHC	ug/kg	ND	2.8	ND	ND	ND	ND	1.7	1.5	6	
gamma-BHC (Lindane)	ug/kg	ND	2.4	ND	ND	ND	ND	ND	ND	6	
Barium	mg/kg	29	35.6	29.3	21.4	31.8	42.3	121	42.6 *	43.8	I,II
Benzo(g,h,i)perylene	ug/kg	210	ND	846.5	ND	10750	ND	5520	ND	98000	
Benzo(a)pyrene	ug/kg	780	ND	1400	ND	19750	71.5 *	22000	150 *	4000	
Benzo(a)anthracene	ug/kg	580	39.9	980	ND	14800	132	20000	140	700	
Benzo(b)fluoranthene	ug/kg	560	ND	1365	ND	16250	179	16000	200	4000	
Benzo(k)fluoranthene	ug/kg	960	ND	1000	ND	26500	138	17000	140	4000	
Chrysene	ug/kg	610	66.6	990	ND	16300	160	21000	180	1000	
Dibenzo(a,h)anthracene	ug/kg	ND	ND	304	ND	3850	ND	3640	ND	11000	
Indeno(1,2,3-cd)pyrene	ug/kg	210	789.5	789.5	ND	8965	ND	8590	ND	35000	
Beryllium	mg/kg	1.2	1.4	0.8	1.1	1.2	1.5	1.5	1.4	180	
2-Butanone (MEK)	ug/kg	4.6	12.5	ND	ND	ND	9.9	3.9	15.5	570	
Cadmium	mg/kg	ND	ND	1	ND	3.6	0.22	2.43	2.03	6	
Carbon disulfide	ug/kg	3.4	ND	ND	ND	3.5	ND	1.2	4.6	1400	
alpha-Chlordane	ug/kg	ND	ND	ND	ND	1.2	ND	24.7	48.1	2000	
gamma-Chlordane	ug/kg	ND	ND	ND	ND	2.2	2	52.5	86.9	2000	
Chlorobenzilate	ug/kg	ND	ND	ND	ND	ND	ND	160	ND *	0.6	
Chromium	mg/kg	91	61.3 *	50.95	44.8	74.2	64.9	57.8	58.2	85.65	II (x)
Cobalt	mg/kg	6.6	ND	5.5	7	6.6	9.2	6.1	4.4	14.88	
Copper	mg/kg	42.4	28.2 *	55	26.2 *	21.4	26.6	79.7	25.3 *	31.62	
Cyanide	mg/kg	ND	ND	ND	ND	ND	ND	0.002	ND	NDA	
2,4-D	ug/kg	68.5	60.5	ND	ND	47	66.2	61.3	65.8	1700	
4,4'-DDD	ug/kg	ND	4.4	12.2	14	ND	17.3	5	211	700	
4,4'-DDE	ug/kg	4.4	3.5	3.3	3	4	7.8	19.7	4.3	500	
4,4'-DDT	ug/kg	7.7	3.3	17.4	ND	7.6	5	50	ND	1000	
Dibenzofuran	ug/kg	ND	ND	54.7	ND	1340	ND	1000	ND	12000	
Dibromochloromethane	ug/kg	ND	ND	ND	ND	7	ND	ND	ND	38	
Di-n-butylphthalate	ug/kg	ND	65.3	ND	ND	ND	ND	ND	ND	12000	
1,1-Dichloroethene	ug/kg	2.5	1.9	ND	ND	ND	ND	2.2	4.8	1100	
Dieldrin	ug/kg	ND	ND	10	ND *	6.8	ND *	3	ND *	1	
7,12-Dimethybenz(a)anthracene	ug/kg	ND	ND	ND	ND	ND	ND	1730	ND *	700	
Dioxin (TCDD TEQ)	ng/kg	22.35	12.55	9.96	ND	15.17	21.2	15.95	23.56	280	I (x)
Endosulfan I	ug/kg	ND	ND	1.8	ND	ND	ND	1.4	ND	400	
Endosulfan II	ug/kg	ND	ND	6.2	ND	2.9	ND	4.1	ND	400	
Endosulfan sulfate	ug/kg	ND	ND	ND	ND	ND	ND	3.8	ND	400	
Endrin	ug/kg	2.6	ND	5.6	ND	3.5	ND	2.2	ND	400	
Endrin aldehyde	ug/kg	ND	ND	22	ND	6.1	3.6	4.2	ND	400	
bis(2-Ethylhexyl)phthalate	ug/kg	89.2	153	156	ND	800	350	320	5670	11000	I (x)
Fluoranthene	ug/kg	1000	81.1	1030	ND	24600	278	18000	284	98000	
Fluorene	ug/kg	73.8	ND	87.6	ND	2190	ND	1500	ND	16000	
Heptachlor	ug/kg	ND	ND	ND	ND	ND	ND	1.4	1.6	60	
Heptachlor epoxide	ug/kg	ND	ND	7.3	ND	ND	ND	16.2	ND	30	
Hexachlorobutadiene	ug/kg	ND	ND	ND	ND	ND	ND	ND	86	100	
sodrin	ug/kg	ND	3.8	ND	ND	ND	3.3	3.3	ND	NDA	
Lead	mg/kg	915	44.7 *	77.5	33	20900	47.4 *	117	41.6	118	I,II (x)

Table 5.5.1
Chemicals Detected in Soil for SWMUs 14, 15, and AOCs 670 and 684
Soil to Groundwater Screening Analysis
NAVBASE-Charleston, Zone H, SWMUs 14, 15 and AOCs 670, 684

Parameter		SWMU 14 Surface Soil	SWMU 14 Subsurface Soil	SWMU 15 Surface Soil	SWMU 15 Subsurface Soil	AOC 670 Surface Soil	AOC 670 Subsurface Soil	AOC 684 Surface Soil	AOC 684 Subsurface Soil	Ground-water Protection SSL	Detected n Ground water
Manganese	mg/kg	473	ND	506	438	418	893	ND	ND	1412	II
Mercury	mg/kg	0.2	0.24	0.16	0.25	0.16	0.86	0.24	0.24	3	
Methoxychlor	ug/kg	ND	ND	ND	ND	13.5	ND	12.6	11.8	62000	
Methylene chloride	ug/kg	ND	ND	ND	ND	29	51 *	212	44.8 *	10	
2-Methylnaphthalene	ug/kg	44.6	ND	ND	ND	260	ND	524	ND *	300	
Naphthalene	ug/kg	ND	ND	ND	ND	585	ND	550	ND	3000	
Nickel	mg/kg	26.7	ND	16.5	13.2	29	23.4	23	15.1	33.38	
Parathion	ug/kg	ND	ND	26.4	ND	24.1	ND	37.5	35.9	390	
Phenanthrene	ug/kg	690	ND	571	ND	18250	6.4	14000	ND	98000	
Pyrene	ug/kg	1000	162	1085	120	22800	281	22000	265	140000	
Selenium	mg/kg	6.2	1.6 *	1.2	1	2.3	3.5 *	2.7	2.1	3	I
Silver	mg/kg	1.8	ND	ND	ND	ND	ND	ND	ND	NDA	
2,4,5-T	ug/kg	17.5	17.5	ND	ND	ND	25.1	18.6	13.7	3300	
2,4,5-TP (Silvex)	ug/kg	13.1	ND	ND	ND	23.8	57.5	26.3	34	120000	
Total Petroleum Hydrocarbons	mg/kg	150	220	ND	ND	ND	ND	7700	13400	NDA	
Tetrachloroethene	ug/kg	ND	ND	ND	ND	ND	ND	1.4	ND	40	
Thallium	mg/kg	0.55	ND	ND	ND	1.4	ND *	2.9	0.86 *	1.3	
Tin	mg/kg	ND	ND	ND	ND	ND	ND	81	60.1	NDA	
Toluene	ug/kg	57.7	17.2	9	4.5	116	60.1	143	66	5000	
1,2,3-Trichloropropane	ug/kg	91.2	ND *	ND	ND	ND	ND	ND	ND	0.006	
Trichloroethene	ug/kg	ND	ND	ND	ND	ND	ND	ND	2.9	20	
Vanadium	mg/kg	71.9	74	51.7	62.3	68.3	84.4	72	81.7	131.6	II (x)
Xylene (total)	ug/kg	5.5	4.4	ND	ND	4.6	2.8	9.3	8.9	74000	
Zinc	mg/kg	103	90.8	166.5	86.2	95	98.9	180	97.9	4200	II

* - Exceeds groundwater protection SSL
I - First quarter groundwater; II - Second quarter groundwater
(x) - Groundwater concentration exceeds tap water RBC
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
ng/kg - nanogram per kilogram
ND - Not detected
NDA - No data available

Table 5.5.2
Contaminants Detected in Groundwater and Surface Water
Groundwater Comparison to the Tap Water Risk-based Concentrations or Grid-based Background UTLs
NAVBASE - Charleston, Zone H, SWMU 14

Parameter	Maximum Conc. Detected in Shallow Ground Water	Maximum Conc. Detected in Surface Water	Media			Tap Water RBC or UTL *	Water Units	Shallow Ground Exceeds RBC or UTL
Aluminum	15500	ND		GS2		3700	ug/L	YES
Arsenic	7.6	338	GS1		SW	27.99	ug/L	NO
Barium	166	162	GS1	GS2	SW	323	ug/L	NO
Chromium	44.4	ND		GS2		18	ug/L	YES
DCAA	103	ND		GS2		NA	ug/L	YES
Dioxin (TCDD TEQ)	10.21	7.327	GS1		SW	0.5	pg/L	YES
bis(2-Ethylhexyl)phthalate (BE	11.8	ND	GS1			4.8	ug/L	YES
Lead	19.7	535	GS1	GS2	SW	15	ug/L	YES
Manganese	2350	ND		GS2		6085	ug/L	NO
Mercury	ND	0.17			SW	1.1	ug/L	NO
Nickel	ND	18.4			SW	73	ug/L	NO
Selenium	1.6	1.4	GS1		SW	18	ug/L	NO
2,4,5-TP (Silvex)	ND	0.34			SW	29	ug/L	NO
Vanadium	65.2	69.6		GS2	SW	26	ug/L	YES
Zinc	82.8	ND		GS2		1100	ug/L	NO

* - See Table 5.2.1
RBC - Risk Based Concentration
UTL - Background Upper Tolerance Limit
GS1 - Shallow groundwater, round 1
GS2 - Shallow groundwater, round 2
SW - Surface water
ND - Not detected
ug/L or pg/L - microgram per liter or picogram per liter

TABLE 5.5.3
Soil-to-Air Volatilization Screening Analysis for SWMU 14, 15, and AOCs 670 and 684
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil SWMU 14	SWMU 15	AOC 670	AOC 684	Soil to Air SSL *	Units	Exceeds SSL
Acetone	ND	0.069	0.078	0.0974	62000	MG/KG	NO
2-Butanone	0.0046	ND	ND	0.0039	1000 +	MG/KG	NO
Carbon disulfide	0.0034	ND	0.0035	0.0012	11	MG/KG	NO
Dibromochloromethane	ND	ND	0.007	ND	0.2 #	MG/KG	NO
1,1-Dichloroethene	0.0025	ND	ND	0.0022	0.04	MG/KG	NO
Methylene chloride	ND	ND	0.029	0.212	7	MG/KG	NO
Tetrachloroethene	ND	ND	ND	0.0014	11	MG/KG	NO
Toluene	0.0577	0.009	0.116	0.143	520	MG/KG	NO
1,2,3-Trichloropropane	0.0912	ND	ND	ND	3E-05	MG/KG	YES
Xylenes (total)	0.0055	ND	0.0046	0.0093	730	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentration Tables, March 1995.

+ - Screening value presented for 2-butanone was conservatively estimated at 10,000 mg/kg; actual may be higher.

- Chloroform soil-to-air screening level applied as a surrogate

ND - Not detected

Table 5.5.4
Chemicals Detected in Surface Soil and Sediment for SWMU 14 (includes SWMU 15, AOCs 670 and 684
NAVBASE-Charleston, Zone H

Parameter	Surface Soil AOC 670	Surface Soil AOC 684	Maximum Surface Soil Concentration AOC 670	Maximum Surface Soil Concentration AOC 684		Sediment AOC 670	Sediment AOC 684	Maximum Sediment Concentration AOC 670	Maximum Sediment Concentration AOC 684	
Acenaphthene	YES	YES	3145	2800	ug/kg	YES	NO	1330		ug/kg
Anthracene	YES	YES	4495	4400	ug/kg	YES	NO	1770		ug/kg
Arsenic	YES	YES	69	16.3	mg/kg	YES	YES	20.3	11.5	mg/kg
Barium	YES	YES	31.8	121	mg/kg	YES	YES	32.5	24.5	mg/kg
Benzo(g,h,i)perylene	YES	YES	1834.3	5520	ug/kg	YES	NO	6510		ug/kg
Benzo(a)pyrene Equiv.	YES	YES	1491	29871	ug/kg	YES	YES	17680	201.1	ug/kg
Beryllium	YES	YES	0.695	1.51	mg/kg	YES	NO	1.2		mg/kg
Cadmium	YES	YES	3.6	2.43	mg/kg	NO	YES		0.63	mg/kg
alpha-Chlordane	YES	YES	1.2	24.7	ug/kg	YES	YES	2.3	58.7	ug/kg
gamma-Chlordane	YES	YES	2.2	52.5	ug/kg	NO	YES		98.1	ug/kg
Chromium	YES	YES	74.2	57.8	mg/kg	YES	YES	45.8	43.8	mg/kg
Cobalt	YES	YES	6.6	6.1	mg/kg	YES	NO	7.6		mg/kg
Copper	YES	YES	21.4	79.7	mg/kg	YES	YES	21	50.8	mg/kg
2,4-D	YES	YES	47	61.3	ug/kg	NO	YES		116	ug/kg
4,4-DDD	NO	YES		5	ug/kg	YES	YES	3.6	338	ug/kg
4,4'-DDE	YES	YES	4	19.7	ug/kg	NO	YES		89.2	ug/kg
4,4'-DDT	YES	YES	7.6	50	ug/kg	YES	YES	6.7	25.3	ug/kg
Dibenzofuran	YES	YES	1340	1000	ug/kg	YES	NO	472		ug/kg
Dioxin (TCDD TEQ)	YES	YES	15.174	15.953	ng/kg	YES	YES	67.871	31.903	ng/kg
Endosulfan II	YES	YES	2.9	4.1	ug/kg	YES	NO	4.6		ug/kg
Endrin	YES	YES	3.5	2.2	ug/kg	YES	YES	11.5	5.8	ug/kg
Endrin aldehyde	YES	YES	6.1	4.2	ug/kg	NO	YES		4	ug/kg
bis(2-Ethylhexyl)phthalate	YES	YES	800	320	ug/kg	NO	YES		156	ug/kg
Fluoranthene	YES	YES	24600	18000	ug/kg	YES	YES	12800	746	ug/kg
Fluorene	YES	YES	2190	1500	ug/kg	YES	YES	842	157	ug/kg
Lead	YES	YES	20900	117	mg/kg	NO	YES		148	mg/kg
Mercury	YES	YES	0.16	0.24	mg/kg	YES	YES	0.27	0.07	mg/kg
Methylene chloride	YES	YES	29	212	ug/kg	YES	NO	172		ug/kg
Nickel	YES	YES	29	23	mg/kg	YES	YES	14.5	18.6	mg/kg
Phenanthrene	YES	YES	18250	14000	ug/kg	YES	NO	7840		ug/kg
Pyrene	YES	YES	22800	22000	ug/kg	YES	YES	11800	632	ug/kg
Selenium	YES	YES	2.3	2.7	mg/kg	YES	YES	1.4	1.2	mg/kg
2,4,5-T	NO	YES		18.6	ug/kg	YES	YES	14.4	19.8	ug/kg
Toluene	YES	YES	116	143	ug/kg	YES	NO	8.2		ug/kg
Petroleum Hydocarbons,TPH	NO	YES		7700	mg/kg	NO	YES		2100	mg/kg
Vanadium	YES	YES	68.3	72	mg/kg	YES	YES	71	56	mg/kg
Xylene (total)	YES	YES	4.6	9.3	ug/kg	YES	YES	1.7	2.8	ug/kg
Zinc	YES	YES	95	180	mg/kg	YES	YES	89.8	136	mg/kg

ug/kg - microgram per kilogram
mg/kg - milligram per kilogram
ng/kg - nanogram per kilogram

Table 5.5.5
Significant Migration Pathways for SWMUs 14, 15 and AOCs 670, 684
NAVBASE-Charleston, Zone H

Parameter	SWMU 14 Soil to Ground Water	SWMU 15 Soil to Ground Water	AOC 670 Soil to Ground Water	AOC 684 Soil to Ground Water	SWMU 14 Ground Water Migration	SWMU 14 Soil to Air
Arsenic					X *	
Chlorinated dibenzodioxins/dibenzofurans					X *	
Lead			X		X *	
1,2,3-Trichloropropane						X **

* - Ecological impacts
** - Areal extent of contaminantion reduces significance
Sediment impacts evaluated in Section 7.0 Ecological Risk Assessment

5.6 SWMU 17

SWMU 17 is the site of an underground fuel pipe that ruptured beneath Building FBM 61 in 1987, releasing an unknown volume of oil. The area where the release occurred, to the north and west of the former building, is capped with asphalt and concrete (Figure 4.4.1). The area east of the building extension is unpaved and grassy. The presence of free-phase product in the environmental medium as a result of the release would affect normal fate and transport dynamics based on different soil characteristics. A tight marsh clay was identified underlying the entire study area. The presence of this clay layer may be sufficient to prevent the vertical penetration of constituents to deeper saturated zones. Specifically, if a significant volume of product migrates vertically through the thin layer of silty, sandy soil to the top of the clay layer and begins to pool, horizontal migration of this mass becomes a dominant migration component. Detailed evaluation relied on available site-specific information to support fate and transport conclusions for SWMU 17. Surface soil, subsurface soil, and shallow and deep groundwater samples were collected from SWMU 17.

Migration pathways for constituents detected at SWMU 17 include soil to groundwater and groundwater to surface water. Groundwater is expected to move north from the site toward the Cooper River. The rate of the vertical migration of contaminants from soil under the paved area to groundwater is expected to be less than the vertical migration in unpaved areas due to the pavement which prevents infiltration of water. No surface water or sediment features are present near SWMU 17; therefore, fate and transport within these media were not evaluated for SWMU 17. Surface water impacts resulting from migration of constituents in groundwater were evaluated based on the Cooper River as the receiving water body.

5.6.1 SWMU 17 — Soil-to-Groundwater Cross-Media Transport

Table 5.6.1 compares constituents found in soil and shallow groundwater to groundwater protection risk-based SSLs, tap water RBCs, and background UTLs. Chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene are highlighted as soil-to-groundwater migration concerns based on their presence in soil and groundwater above the groundwater protection SSLs and tap water RBCs. All four contaminants were detected in monitoring well NBCH017002 at concentrations above the tap water RBCs. Chlorobenzene was also detected above the tap water RBC in monitoring well NBCH017003. These findings suggest an impact to the shallow aquifer due to soil concentrations of chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene; however, this contamination appears to be isolated to the center of SWMU 17.

Quantitative screening also produced four additional constituents (Aroclor-1260, 4,4'-DDE, 2,4-dichlorophenol, and bis(2-ethylhexyl)phthalate) that were detected in soil above the groundwater protection SSLs. Aroclor-1260 was detected above the SSL of 8,200 μg/kg at sample locations 017SB002, 017SB006, and 017SB020 with the maximum detected soil concentration of 245,000 μg/kg at location 017SB002 in the deep interval. Aroclor-1260 was not detected in SWMU 17 shallow groundwater. These findings indicate that Aroclor-1260 has the potential for isolated impacts to the shallow aquifer although this has not currently been confirmed. 4,4'-DDE and 2,4-dichlorophenol were detected infrequently above their groundwater protection SSLs and were not detected in SWMU 17 shallow groundwater. Based on the limited impacts to soil above a conservative groundwater protection SSL and absence from groundwater, SWMU 17 soil concentrations of 4,4'-DDE and 2,4-dichlorophenol are not likely to impact the shallow aquifer. bis(2-Ethylhexyl)phthalate was detected in soil marginally above a conservative groundwater protection SSL in one subsurface soil sample and in shallow groundwater at a concentration below the tap water RBC. Although this suggests the potential for isolated impact to the shallow aquifer, the limited extent of soil contamination indicates a widespread impact to be unlikely. It should be noted that bis(2-ethylhexyl)phthalate is a common laboratory contaminant and conclusion regarding soil to groundwater migration should be considered in light of this uncertainty.

5.6.2 SWMU 17 — Groundwater-to-Surface Water Cross-Media Transport

Seven contaminants (benzidine, chlorobenzene, chromium, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene) exceeded the tap water RBCs in SWMU 17 shallow groundwater. No surface water was sampled during the SWMU 17 RFI. The Cooper River, the closest surface water body to SWMU 17, will be investigated as part of the Zone J RFI. Monitoring well NBCH017002 had detected concentrations of chlorobenzene (4,750 μg/L), 1,2-dichlorobenzene (110 μg/L), 1,3-dichlorobenzene (750 μg/L), 1,4-dichlorobenzene (1,100 μg/L), and 1,2,4-trichlorobenzene (1,000 μg/L) in shallow groundwater, significantly exceeding their respective tap water RBCs. Other impacted monitoring wells include NBCH017001, with a chromium concentration of 40 μg/L, which is above the tap water RBC of 18 μg/L; and NBCH017005, with a benzidine concentration of 56 μg/L (first quarter only), which exceeds the tap water RBC of 0.00029 μg/L.

Groundwater travel time from SWMU 17 to the Cooper River has been estimated at 44 years. Benzidene is the most mobile organic compound of the contaminants that exceed tap water RBCs in SWMU 17 shallow groundwater based on its ability to partition to water. Applying a retardation factor of 4 results in a predicted travel time of approximately 176 years for benzidine. Based on the isolated nature of the groundwater contamination at SWMU 17, the predicted travel times to surface water (not considering the attenuative capacity of the aquifer matrix), and the dilutional capacity of the receiving stream, no significant surface water impacts are expected. The Zone J RFI will serve to affirm this conclusion.

5.6.3 SWMU 17 — Soil-to-Air Cross-Media Transport

Table 5.6.2 lists the VOCs detected in surface soil samples collected at SWMU 17, along with corresponding soil-to-air volatilization screening levels. The maximum surface soil concentration of no VOC exceeded its corresponding soil-to-air volatilization screening levels. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

5.6.4 SWMU 17 — Fate and Transport Summary

Table 5.6.3 lists all the contaminants found to be significant in terms of fate and transport with a notation of the significant migration pathways for each contaminant.

Table 5.6.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for SWMU 17
NAVBASE-Charleston, Zone H

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil aximum Conc.	Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Water Units	Exceeds Tap Water RBC	Exceeds Ground Water Protection SSL
Acenaphthene	ND	210	20000	ug/kg	ND	220	ug/L	NO	NO
Acetone	195	176	800	ug/kg	17.9	370	ug/L	NO	NO
Aluminum	14500	30100	46180	mg/kg	522	3700	ug/L	NO	NO
Antimony	10.1	ND	NA	mg/kg	ND	1.5	ug/L	NO	NO
Aroclor-1254	42	ND	8200	ug/kg	ND	0.0087	ug/L	NO	NO
Aroclor-1260	180000	245000	8200	ug/kg	ND	0.0087	ug/L	NO	YES
Arsenic	7.9	25.6	35.52	mg/kg	4.9	27.99	ug/L	NO	NO
Barium	23.5	25.7	43.8	mg/kg	19.65	323	ug/L	NO	NO
Benzidine	ND	ND	0.0011	ug/kg	56	0.00029	ug/L	YES	NO
Benzo(g,h,i)perylene	66.7	ND	98000	ug/kg	ND	150	ug/L	NO	NO
Benzo(a)pyrene Equivalents	220.301	0.133	4000	ug/kg	ND	0.0092	ug/L	NO	NO
Benzoic acid	215	99.1	28000	ug/kg	ND	15000	ug/L	NO	NO
Beryllium	0.64	1.4	180	mg/kg	ND	0.016	ug/L	NO	NO
2-Butanone (MEK)	ND	39.4	570	ug/kg	ND	190	ug/L	NO	NO
Butylbenzylphthalate	130	ND	6800	ug/kg	ND	730	ug/L	NO	NO
Cadmium	4.7	0.29	6	mg/kg	ND	1.8	ug/L	NO	NO
alpha-Chlordane	5.1	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
gamma-Chlordane	12.3	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
Chlorobenzene	ND	827	60	ug/kg	4750	3.9	ug/L	YES	YES
Chromium	35	47.3	85.65	mg/kg	40	18	ug/L	YES	NO
Cobalt	9.8	5.7	14.88	mg/kg	2.7	220	ug/L	NO	NO
Copper	74.1	19.5	31.62	mg/kg	3	140	ug/L	NO	YES
Cyanide	3	7.4	NA	mg/kg	ND	73	ug/L	NO	NO
4,4'-DDD	2.9	75	700	ug/kg	ND	0.28	ug/L	NO	NO
4,4'-DDE	581	652	500	ug/kg	ND	0.2	ug/L	NO	YES
Dibenzofuran	ND	110	12000	ug/kg	ND	15	ug/L	NO	NO
Di-n-butylphthalate	71.4	131	12000	ug/kg	3.2	370	ug/L	NO	NO
1,2-Dichlorobenzene	ND	219	600	ug/kg	110	27	ug/L	YES	NO
1,3-Dichlorobenzene	43.6	6680	600	ug/kg	750	54	ug/L	YES	YES
1,4-Dichlorobenzene	ND	5840	1000	ug/kg	1100	0.44	ug/L	YES	YES
2,4-Dichlorophenol	ND	63.7	50	ug/kg	ND	11	ug/L	NO	YES
Di-n-octylphthalate	ND	317	1E+08	ug/kg	ND	73	ug/L	NO	NO
Dioxin (TCDD TEQ)	127.0313	53.9209	280	ng/kg	ND	0.5	pg/L	NO	NO
Endrin	2.7	ND	400	ug/kg	ND	1.1	ug/L	NO	NO
bis(2-Ethylhexyl)phthalate	830	11300	11000	ug/kg	4	4.8	ug/L	NO	YES
Fluoranthene	346	470	98000	ug/kg	ND	150	ug/L	NO	NO
Fluorene	ND	140	16000	ug/kg	ND	150	ug/L	NO	NO
Hexachlorobenzene	ND	285	800	ug/kg	ND	0.0066	ug/L	NO	NO
Lead	41	32.4	118	mg/kg	ND	15	ug/L	NO	NO
Manganese	203	668	1412	mg/kg	896.5	3391	ug/L	NO	NO
Mercury	0.66	0.3	3	mg/kg	ND	1.1	ug/L	NO	NO
Methylene chloride	ND	ND	10	ug/kg	ND	4.1	ug/L	NO	NO

Table 5.6.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for SWMU 17
NAVBASE-Charleston, Zone H

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil aximum Conc.	Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Water Units	Exceeds Tap Water RBC	Exceeds Ground Water Protection SSL
2-Methylnaphthalene	ND	ND	3000	ug/kg	4	150	ug/L	NO	NO
Naphthalene	ND	140	3000	ug/kg	6.1	150	ug/L	NO	NO
Nickel	18.3	10.2	33.38	mg/kg	ND	73	ug/L	NO	NO
Phenanthrene	188	510	98000	ug/kg	ND	150	ug/L	NO	NO
Pyrene	280	300	140000	ug/kg	ND	110	ug/L	NO	NO
Selenium	ND	1.9	3	mg/kg	3.9	18	ug/L	NO	NO
Silver	34.4	ND	NA	mg/kg	ND	18	ug/L	NO	NO
2,4,5-T	7.5	9.9	260	ug/kg	ND	37	ug/L	NO	NO
Total Petroleum Hydrocarbons	1200	820	NA	ug/kg	ND	NA	ug/L	NO	NO
Toluene	9.6	ND	5000	ug/kg	ND	75	ug/L	NO	NO
1,2,4-Trichlorobenzene	ND	49600	2000	ug/kg	1000	19	ug/L	YES	YES
Trichloroethene	1.8	ND	20	ug/kg	ND	1.6	ug/L	NO	NO
2,4,5-Trichlorophenol	ND	ND	12000	ug/kg	19	370	ug/L	NO	NO
Vanadium	61.6	66.4	131.6	mg/kg	3.4	26	ug/L	NO	NO
Zinc	267	116	4200	mg/kg	25	1100	ug/L	NO	NO

* - See Table 5.2.1
SSL - Soil Screening Level
RBC - Risk-based Concentration
UTL - Background Upper Tolerance Level
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
ND- Not detected
NA - Not available

TABLE 5.6.2
Soil-to-Air Volatilization Screening Analysis for SWMU 17
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.195	62000	MG/KG	NO
1,3-Dichlorobenzene	0.0436	300	MG/KG	NO
Toluene	0.0096	520	MG/KG	NO
Trichloroethene	0.0018	3	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrat Tables, March 1995.

Table 5.6.3
Significant Migration Pathways for SWMU 17
NAVBASE-Charleston, Zone H

Parameter	SWMU 17 Soil to Ground Water	SWMU 17 Ground Water Migration	SWMU 17 Soil to Air
Aroclor-1260	X		
Benzidine		X	
Chlorobenzene	X	X	
1,2-Diclorobenzene		X	
1,3-Diclorobenzene	X	X	
1,4-Dichlorobenzene	X	X	
1,2,4-Trichlorobenzene	X	X	

5.7 SWMU 159

SWMU 159, near building 665 in the southcentral portion of Zone H, is a former SAA used for the temporary storage of hazardous materials such as batteries, aerosol cans, and paint. An AST containing diesel fuel, a can crusher, and scattered debris were also at this SWMU. Migration pathways for SWMU 159 include soil to groundwater, surface soil to air, and surface soil to sediment/surface water. Surface soil, subsurface soil, surface water, and sediment samples were collected from SWMU 159.

5.7.1 SWMU 159 — Soil-to-Groundwater Cross-Media Transport

Table 5.7.1 compares constituents detected in SWMU 159 soil to risk-based SSLs and background UTLs. No groundwater samples were collected from SWMU 159 with which to conduct qualitative screening for the soil-to-groundwater migration pathway. Quantitative screening identified four constituents (barium, copper, selenium, and trichloroethene) that marginally exceeded their soil screening criteria. These constituents were detected above the groundwater protection SSLs or background UTLs in only one or two soil samples apiece. The limited presence of these constituents at concentrations slightly above conservative screening levels would not be expected to threaten the shallow aquifer. These findings indicate that SWMU 159 soil concentrations are protective of the shallow aquifer.

5.7.2 SWMU 159 — Surface Soil-to-Sediment/Surface Water

Table 5.7.1 summarizes the soil and sediment concentrations for SWMU 159. Numerous organics and inorganics were detected in both media at similar concentrations. This suggests that surface soil erosion forming sedimentary deposits in the adjacent tidal estuary may be significant in terms of fate and transport. Three constituents (bis[2-ethylhexyl]phthalate, heptachlor, and heptachlor epoxide) were detected in sediment at a significantly higher concentration than in surface soil. 2-Butanone and butylbenzylphthalate were detected in sediment only and cannot be related to a potential surface soil source.

No constituents were detected in surface water samples collected for SWMU 159 above salt-water chronic WQC. These findings suggest that surface soil concentrations are protective of the surface water environment included as part of the SWMU 159 RFI. Section 7 addresses any potential ecological impact for SWMU 159.

5.7.3 SWMU 159 — Soil-to-Air Cross-Media Transport

Table 5.7.2 lists the VOCs detected in surface soil samples collected at SWMU 159, along with corresponding soil-to-air volatilization screening levels. No VOC's maximum surface soil concentration exceeded its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.7.1
Chemicals Detected in Soil, Sediment and Surface Water
Soil Comparison to Groundwater Protection SSL and Background UTLs
NAVBASE-Charleston, Zone H, SWMU 159

Parameter	Surface Soil aximum Conc.	Sub-Surface Soil aximum Conc.	Ground Water Protection SSL or UTL *	Sediment Maximum Conc.	Soil Units	Surface Water Maximum Conc.	Units	Soil Exceeds SSL or UTL
Acenaphthene	ND	430	20000	ND	ug/kg	ND	UG/L	NO
Acetone	41	180	800	210	ug/kg	ND	UG/L	NO
Aluminum	29300	30200	46180	32900	mg/kg	257	UG/L	NO
Anthracene	ND	480	430000	ND	ug/kg	ND	UG/L	NO
Arsenic	12.8	12.6	35.52	15.5	mg/kg	2.8	UG/L	NO
Barium	47.1	81.2	43.8	61.2	mg/kg	30.4	UG/L	YES
Benzo(g,h,i)perylene	ND	ND	98000	270	ug/kg	ND	UG/L	NO
Benzo(a)pyrene Equivalents	127.45	30.14	4000	599.8	ug/kg	ND	UG/L	NO
Beryllium	1.2	1.3	180	1.1	mg/kg	ND	UG/L	NO
2-Butanone (MEK)	ND	ND	190	43	ug/kg	ND	UG/L	NO
Butylbenzylphthalate	ND	ND	730	210	ug/kg	ND	UG/L	NO
Cadmium	0.41	1.1	6	1	mg/kg	ND	UG/L	NO
alpha-Chlordane	120	3.1	2000	560	ug/kg	ND	UG/L	NO
gamma-Chlordane	130	5.3	2000	760	ug/kg	ND	UG/L	NO
Chromium	72.3	68.1	85.65	68.6	mg/kg	ND	UG/L	NO
Cobalt	6.4	5.9	14.88	6.4	mg/kg	ND	UG/L	NO
Copper	46.1	16.2	31.62	29.4	mg/kg	ND	UG/L	YES
Total Cresol	284.39	ND	600	NA	ug/kg	ND	UG/L	NO
2,4-D	20.2	ND	1700	ND	ug/kg	ND	UG/L	NO
4,4'-DDE	16	4.3	500	ND	ug/kg	ND	UG/L	NO
4,4'-DDT	5.6	ND	1000	ND	ug/kg	ND	UG/L	NO
Dioxin (TCDD TEQ)	8.9	ND	280	ND	ng/kg	ND	UG/L	NO
Endrin	2.5	ND	400	ND	ug/kg	ND	UG/L	NO
bis(2-Ethylhexyl)phthlate	190	ND	11000	2400	ug/kg	ND	UG/L	NO
Fluoranthene	130	1200	98000	920	ug/kg	ND	UG/L	NO
Fluorene	ND	230	16000	ND	ug/kg	ND	UG/L	NO
Heptachlor	2.3	ND	60	62	ug/kg	ND	UG/L	NO
Heptachlor epoxide	3.6	ND	30	72	ug/kg	ND	UG/L	NO
Lead	92	41	118	89.1	mg/kg	ND	UG/L	NO
Manganese	307	247	1412	245	mg/kg	312	UG/L	NO
Mercury	0.15	0.13	3	0.15	mg/kg	ND	UG/L	NO
Nickel	16.3	20.6	33.38	14.3	mg/kg	ND	UG/L	NO
Phenanthrene	310	200	98000	310	ug/kg	ND	UG/L	NO
Pyrene	96	960	140000	720	ug/kg	ND	UG/L	NO
Selenium	2.3	3.6	3	2.7	mg/kg	ND	UG/L	YES
Silver	0.53	0.33	NA	0.54	mg/kg	ND	UG/L	NO
2,4,5-T	53.5	ND	260	ND	ug/kg	ND	UG/L	NO
2,4,5-TP (Silvex)	30	ND	1580	ND	ug/kg	ND	UG/L	NO
Trichloroethene	21	20	20	17	ug/kg	ND	UG/L	YES
Vanadium	62.6	65.3	131.6	66.2	mg/kg	6.5	UG/L	NO
Zinc	101	69.8	4200	279	mg/kg	59.9	UG/L	NO

* - See table 5.2-1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - micrgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected
The groundwater protection SSL for 2-methylcresol was used as a suurrogate for total cresols.

TABLE 5.7.2
Soil-to-Air Volatilization Screening Analysis for AOC 159
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.041	62000	MG/KG	NO
Methylene chloride	0.0129	7	MG/KG	NO
Trichloroethene	0.021	3	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrat
Tables, March 1995.

5.8 SWMU 178

SWMU 178 is the site of a transformer oil leak from an underground transformer vault approximately 50 feet south of Building X33-A. A fuel oil UST is approximately 30 feet north/northeast of the transformer vault. A portion of the SWMU 178 area is covered with asphalt/concrete. However, the area within the fence immediately surrounding the transformer vault was not paved and contained little vegetation. Migration pathways for SWMU 178 include soil to groundwater, surface soil to air, and groundwater to surface water. The Cooper River is the closest potential surface water receptor for SWMU 178.

5.8.1 SWMU 178 — Soil-to-Groundwater Cross-Media Transport

Table 5.8.1 compares constituent concentrations to groundwater protection SSLs, tap water RBCs and/or background UTLs. Thallium was detected in soil at concentrations exceeding its background UTL. Antimony and petroleum hydrocarbons were detected in soil, but in the absence of a groundwater protection SSL for these constituents, the soil-to-groundwater quantitative screening was not performed. The maximum detected concentration (37,000 mg/kg) of TPH in SWMU 178 soil occurred near the UST. No constituents detected in SWMU 178 soil were detected in excess of the tap water RBC or background UTL in SWMU 178 shallow groundwater. This indicates that SWMU 178 soil is protective of the shallow aquifer, although TPH soil concentrations would suggest a potential threat to ground water.

5.8.2 SWMU 178 — Groundwater-to-Surface Water Cross-Media Transport

A number of inorganics but no organic compounds were detected in SWMU 178 groundwater. Bis(2-ethylhexyl)phthalate was detected in one of two duplicate samples collected in NBCH178001 during second-quarter sampling. Based on review of associated QA/QC results and those of the other replicate, the hit is suspect. As a result, bis(2-ethylhexyl)phthalate transport in groundwater was not evaluated. No constituent was detected in shallow groundwater above the tap water RBC or background UTL. SWMU 178 has no surface water feature present, so qualitative screening was not performed for the groundwater-to-surface water migration pathway. The Cooper River, the closest surface water body to SWMU 178, will be investigated as part of the Zone J RFI. Groundwater travel time from SWMU 178 to the Cooper River is estimated to be 107 years. Based on groundwater impacts limited to inorganics, the predicted travel times to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected. The Zone J RFI will affirm this conclusion.

5.8.3 SWMU 178 — Soil-to-Air Cross-Media Transport

Table 5.8.2 lists the single VOC (toluene) detected in surface soil samples collected at SWMU 178, along with its corresponding soil-to-air volatilization screening level. The maximum surface soil concentration of toluene did not exceed its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.8.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for SWMU 178
NAVBASE-Charleston, Zone H

Parameter	Surface Soil aximum Conc.	Sub-surface Soil aximum Conc.	Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or UTL
Acetone	ND	52	800	ug/kg	ND	370	ug/L	NO	NO
Acetonitrile	ND	7.8	70	ug/kg	ND	22	ug/L	NO	NO
Aluminum	11000	6050	46180	mg/kg	140.35	3700	ug/L	NO	NO
Antimony	1.4	8.6	NA	mg/kg	ND	1.5	ug/L	NO	NO
Arsenic	7.7	8.7	35.52	mg/kg	5.25	27.99	ug/L	NO	NO
Barium	40.3	7.8	43.8	mg/kg	4.45	323	ug/L	NO	NO
Benzo(a)pyrene Equivalents	175.45	ND	4000	ug/kg	ND	0.0092	ug/L	NO	NO
Beryllium	0.08	0.31	180	mg/kg	ND	0.016	ug/L	NO	NO
2-Butanone (MEK)	ND	10	570	ug/kg	ND	190	ug/L	NO	NO
alpha-Chlordane	3	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
gamma-Chlordane	8	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
Chlorobenzene	ND	6	60	ug/kg	ND	3.9	ug/L	NO	NO
Chromium	14.9	49	85.65	mg/kg	2.7	18	ug/L	NO	NO
Cobalt	0.68	1.1	14.88	mg/kg	ND	220	ug/L	NO	NO
Copper	15.3	6.8	31.62	mg/kg	ND	140	ug/L	NO	NO
4,4'-DDD	4	92	700	ug/kg	ND	0.28	ug/L	NO	NO
4,4'-DDE	220	35	500	ug/kg	ND	0.2	ug/L	NO	NO
4,4'-DDT	93	10	1000	ug/kg	ND	0.2	ug/L	NO	NO
Di-n-octylphthalate	ND	226	1E+08	ug/kg	ND	73	ug/L	NO	NO
Dioxin (TCDD TEQ)	ND	0.53	280	ng/kg	ND	0.5	pg/L	NO	NO
Fluoranthene	270	210	98000	ug/kg	ND	150	ug/L	NO	NO
Heptachlor epoxide	3	ND	30	ug/kg	ND	0.0012	ug/L	NO	NO
Lead	5.5	5.1	118	mg/kg	2.65	15	ug/L	NO	NO
Manganese	66.1	46.8	1412	mg/kg	158	3391	ug/L	NO	NO
Mercury	ND	0.03	3	mg/kg	ND	1.1	ug/L	NO	NO
Nickel	ND	20.8	33.38	mg/kg	6.9	73	ug/L	NO	NO
Phenanthrene	110	ND	98000	ug/kg	ND	150	ug/L	NO	NO
Pyrene	290	270	140000	ug/kg	ND	110	ug/L	NO	NO
Selenium	0.93	0.7	3	mg/kg	3.5	18	ug/L	NO	NO
Total Petroleum Hydrocarbons	900	37000	NA	mg/kg	ND	NA	ug/L	NO	NO
Thallium	ND	2.2	1.3	mg/kg	ND	7.66	ug/L	NO	YES
Toluene	11	8.95	5000	ug/kg	ND	75	ug/L	NO	NO
Vanadium	16.8	25.4	131.6	mg/kg	4.5	26	ug/L	NO	NO
Xylene (total)	ND	5.1	74000	ug/kg	ND	1200	ug/L	NO	NO
Zinc	160	37.2	4200	mg/kg	5.9	1100	ug/L	NO	NO

* - See Table 5.2.1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected

TABLE 5.8.2
Soil-to-Air Volatilization Screening Analysis for AOC 178
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Toluene	0.011	520	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrat Tables, March 1995.

5.9 AOC 653

AOC 653 is a hydraulic fluid storage tank at the west end of Building 1508 that is no longer in service due to a suspected leak. The entire area of AOC 653 is covered with asphalt and/or concrete. Migration pathways evaluated for AOC 653 include soil to groundwater, surface soil to air, and groundwater to surface water. Migration of contaminants along these pathways at AOC 653 are expected to be minimal due to the presence of the asphalt/concrete cover. Surface soil, subsurface soil and groundwater samples were collected near AOC 653 as part of the Zone H RFI.

5.9.1 AOC 653 — Soil-to-Groundwater Cross-Media Transport

Table 5.9.1 compares constituent concentrations to groundwater protection SSLs, tap water RBCs, and background UTLs. Acrylonitrile, barium, lead, methyl parathion, and 4-nitrophenol were detected in soil at concentrations exceeding groundwater protection SSLs or background UTLs. Acrylonitrile and methyl parathion were not detected in either AOC 653 subsurface soil. 4-Nitrophenol was detected in one subsurface soil sample. Lead and barium were detected over their background UTLs in only one or two soil samples. Acrylonitrile, barium, lead, methyl parathion, and 4-nitrophenol were not detected in AOC 653 shallow groundwater. Although conservative screening indicates potential for isolated soil to groundwater migration the limited extent of these constituent in AOC 653 soil and their absence from shallow groundwater suggest that significant migration is unlikely. Total petroleum hydrocarbons were detected in soil at a concentration of 42,000 mg/kg, but in the absence of an SSL for this constituent, the soil-to-groundwater quantitative screening was not performed.

5.9.2 AOC 653 — Groundwater-to-Surface Water Cross-Media Transport

Arsenic was detected in AOC 653 shallow groundwater at a concentration of 34.5 μg/L, which is above the background UTL (27.99 μg/L) and the maximum contaminant level (MCL) (5 μg/L). Considering soil's neutral to high pH, arsenic is expected precipitate and sorb to the soil matrix rather than migrate in groundwater. AOC 653 has no surface water feature present so qualitative screening was not performed for the groundwater-to-surface water migration pathway. The Cooper River is the closest surface water body to AOC 653, and will be investigated as part of the Zone J RFI. Groundwater travel time from AOC 653 to the Cooper River is estimated to be 171 years. Based the predicted travel times to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected. The Zone J RFI will affirm this conclusion.

5.9.3 AOC 653 — Soil-to-Air Cross-Media Transport

Table 5.9.2 lists the VOCs detected in surface soil samples collected at AOC 653 along with corresponding soil-to-air volatilization screening level. No VOC's maximum surface soil concentration compound exceeded its corresponding soil-to-air volatilization screening level. A conservative soil-to-air screening value of 10,000 mg/kg was used for 2-butanone. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.9.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for AOC 653
NAVBASE-Charleston, Zone H

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil Maximum Conc.	Ground Water Protection SSL or UTL *	Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or UTL
Acetone	131.5	83	800	ug/kg	ND	370	ug/L	NO	NO
Acrylonitrile	23.9	ND	0.04	ug/kg	ND	0.12	ug/L	NO	YES
Aluminum	4580	13400	46180	mg/kg	248	3700	ug/L	NO	NO
Aroclor-1248	88	ND	8200	ug/kg	ND	0.0087	ug/L	NO	NO
Aroclor-1260	71	ND	8200	ug/kg	ND	0.0087	ug/L	NO	NO
Arsenic	9.3	14.9	35.52	mg/kg	34.5	27.99	ug/L	YES	NO
Barium	49.8	24.2	43.8	mg/kg	ND	323	ug/L	NO	YES
Benzo(a)pyrene Equivalents	ND	171.6	4000	ug/kg	ND	0.0092	ug/L	NO	NO
Beryllium	0.39	0.75	180	mg/kg	ND	0.016	ug/L	NO	NO
4-Bromophenyl-phenylether	ND	5	36600	ug/kg	ND	210	ug/L	NO	NO
2-Butanone (MEK)	23.4	14	570	ug/kg	ND	190	ug/L	NO	NO
Butylbenzylphthalate	110	ND	6800	ug/kg	ND	730	ug/L	NO	NO
Cadmium	0.94	ND	6	mg/kg	ND	1.8	ug/L	NO	NO
alpha-Chlordane	2	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
gamma-Chlordane	4	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
Chromium	18.2	23.5	85.65	mg/kg	ND	18	ug/L	NO	NO
Cobalt	5.4	4.9	14.88	mg/kg	ND	220	ug/L	NO	NO
Copper	25.35	18	31.62	mg/kg	ND	140	ug/L	NO	NO
4,4'-DDD	180	9	700	ug/kg	ND	0.28	ug/L	NO	NO
4,4'-DDE	320	8	500	ug/kg	ND	0.2	ug/L	NO	NO
4,4'-DDT	ND	ND	1000	ug/kg	0.06	0.2	ug/L	NO	NO
Dioxin (TCDD TEQ)	43.415	8.677	280	ng/kg	ND	0.5	pg/L	NO	NO
bis(2-Ethylhexyl)phthalate	6695	110	11000	ug/kg	ND	4.8	ug/L	NO	NO
Fluoranthene	ND	260	98000	ug/kg	ND	150	ug/L	NO	NO
Fluorene	441	ND	16000	ug/kg	ND	150	ug/L	NO	NO
Lead	561	53.5	118	mg/kg	ND	15	ug/L	NO	YES
Manganese	233	418	1412	mg/kg	672	3391	ug/L	NO	NO
Mercury	0.22	0.24	3	mg/kg	ND	1.1	ug/L	NO	NO
Methyl parathion	33.2	ND	4.1	ug/kg	ND	0.91	ug/L	NO	YES
4-Methyl-2-Pentanone (MIBK)	1.6	ND	900	ug/kg	ND	290	ug/L	NO	NO
2-Methylnaphthalene	1520	ND	3000	ug/kg	ND	150	ug/L	NO	NO
4-Methylphenol	260	ND	600	ug/kg	ND	18	ug/L	NO	NO
Naphthalene	739	ND	3000	ug/kg	ND	150	ug/L	NO	NO
Nickel	12.7	8.3	33.38	mg/kg	ND	73	ug/L	NO	NO
4-Nitrophenol	ND	2500	1670	ug/kg	ND	230	ug/L	NO	YES
Phenanthrene	711	200	98000	ug/kg	ND	150	ug/L	NO	NO
Pyrene	801	370	140000	ug/kg	ND	110	ug/L	NO	NO
Selenium	ND	ND	3	mg/kg	1.2	18	ug/L	NO	NO
Total Petroleum Hydrocarbons	42000	440000	NA	mg/kg	ND	NA	ug/L	NO	NO
Thallium	ND	ND	1.3	mg/kg	1.2	7.66	ug/L	NO	NO
Toluene	20	7	5000	ug/kg	ND	75	ug/L	NO	NO
Vanadium	18	39.9	131.6	mg/kg	4.6	26	ug/L	NO	NO
Xylene (total)	2.2	ND	74000	ug/kg	ND	1200	ug/L	NO	NO
Zinc	165.5	78.8	4200	mg/kg	ND	1100	ug/L	NO	NO

* - See Table 5.2-1
SSL - Soil Screening Level
RBC - Risk-based Concentration
UTL - Upper Tolerance Level
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
ND - Not detected
NA - Not available

TABLE 5.9.2
Soil-to-Air Volatilization Screening Analysis for AOC 653
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.1315	62000	MG/KG	NO
2-Butanone	0.0234	10000 +	MG/KG	NO
Toluene	0.02	520	MG/KG	NO
Xylene (total)	0.0022	730	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrat Tables, March 1995.

+ - Screening value presented for 2-butanone was conservatively estimated at 10,000; actual may be higher.

5.10 AOC 655

AOC 655 is the site of a 1985 fuel line rupture that released approximately 300 gallons of No. 2 fuel oil. The fuel line supplied the Building 656 boiler from a nearby 5,800-gallon UST. A large portion of the site is covered with asphalt or concrete. The southern end of the building is a loading dock with a paved parking area. A small area between Building 656 and the UST is covered with grass and gravel. Remaining portions of the site are covered with grass and a sidewalk. Migration pathways for AOC 655 include soil to groundwater, surface soil to air and groundwater to surface water. Movement of contaminants with sediment and/or surface water is not likely due to the absence of any defined drainage feature at the AOC and the fact that most of the AOC is covered with either grass, asphalt, or concrete. Surface soil, subsurface soil and groundwater samples were collected at AOC 655.

5.10.1 AOC 655 — Soil to Groundwater Cross Media Transport

Table 5.10.1 compares constituent concentrations to groundwater protection SSLs, tap water RBCs, and background UTLs. Acetone, aldrin, copper, dieldrin, lead, and methylene chloride were detected in soil at concentrations exceeding groundwater protection SSLs or background UTLs. Acetone, aldrin, copper, dieldrin, lead and methylene chloride were not detected in AOC 655 shallow groundwater. Copper and lead were detected above the background UTLs in only one or two soil samples and are therefore not considered a significant migration threat. Acetone, dieldrin, and aldrin were detected above groundwater protection SSLs in only one or two soil samples. Although conservative screening has indicated the potential for isolated soil to groundwater migration, the limited extent of acetone, dieldrin, and aldrin in soil and their absence from groundwater suggest that this is not likely to a significant process. Total petroleum hydrocarbons were detected in soil, but in the absence of SSLs for these constituents, the soil-to-groundwater quantitative screening was not performed for these compounds. Methylene chloride was detected above a conservative groundwater protection SSL in 7 of 10 surface and 4 of 4 subsurface soil samples, however, methylene chloride was not detected in AOC 655 shallow groundwater. Although the potential exists for methylene chloride soil to groundwater migration this does not appear to be a significant process. It should be noted that methylene chloride is a common laboratory contaminant and subsequent quarterly groundwater sampling should be reviewed to confirm fate and transport conclusions.

5.10.2 AOC 655 — Groundwater-to-Surface Water Cross-Media Transport

Arsenic and gamma-chlordane were detected in shallow groundwater at concentrations marginally above the tap water RBCs or background UTLs. Considering soil's neutral to high pH, arsenic is expected precipitate and sorb to the soil matrix rather than migrate in groundwater. Considering a K_{oc} value of 49,500, gamma-chlordane is expected to sorb to the soil matrix rather than migrate in groundwater. AOC 655 has no surface water feature, so qualitative screening was not performed for the groundwater-to-surface water migration pathway. The Cooper River, the closest surface water body to AOC 655, will be investigated as part of the Zone J RFI. Groundwater travel time from AOC 655 to the Cooper River is estimated to be 171 years. Based on the predicted travel times to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected.

5.10.3 AOC 655 — Soil-to-Air Cross-Media Transport

Table 5.10.2 lists the VOCs detected in surface soil samples collected at AOC 655, along with corresponding soil-to-air volatilization screening level. No VOC's maximum surface soil concentration exceeded its corresponding soil-to-air volatilization screening level. A conservative soil-to-air screening value of 10,000 mg/kg was used for 2-butanone. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.10.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Grid-based Background UTLs
NAVBASE-Charleston, Zone H, AOC 655

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil Maximum Conc.	Ground Water Protection SSL or UTL *	Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Units	Exceeds Tap Water RBC	Exceeds Ground Water Protection SSL
Acenaphthene	140	ND	20000	UG/KG	ND	220	UG/L	NO	NO
Acenaphthylene	440	ND	20000	UG/KG	ND	220	UG/L	NO	NO
Acetone	4400	180	800	UG/KG	ND	370	UG/L	NO	YES
Aldrin	ND	87	5	UG/KG	ND	0.004	UG/L	NO	YES
Aluminum	15300	6640	46180	MG/KG	1750	3700	UG/L	NO	NO
Anthracene	1800	ND	430000	UG/KG	ND	1100	UG/L	NO	NO
Aroclor-1254	110	180	8200	UG/KG	ND	0.0087	UG/L	NO	NO
Aroclor-1260	610	750	8200	UG/KG	ND	0.0087	UG/L	NO	NO
Arsenic	12.7	2.8	35.52	MG/KG	42.3	27.99	UG/L	YES	NO
Barium	23.2	19.9	43.8	MG/KG	255	323	UG/L	NO	NO
Benzo(g,h,i)perylene	960	ND	98000	UG/KG	ND	150	UG/L	NO	NO
Benzo(a)pyrene Equivalents	3590.7	ND	4000	UG/KG	ND	0.0092	UG/L	NO	NO
Beryllium	0.91	0.21	180	MG/KG	ND	0.016	UG/L	NO	NO
2-Butanone (MEK)	19	ND	570	UG/KG	ND	190	UG/L	NO	NO
Butylbenzylphthalate	98	ND	6800	UG/KG	ND	730	UG/L	NO	NO
Cadmium	0.56	ND	6	MG/KG	ND	1.8	UG/L	NO	NO
alpha-Chlordane	97	9	2000	UG/KG	0.04	0.052	UG/L	NO	NO
gamma-Chlordane	130	22	2000	UG/KG	0.06	0.052	UG/L	YES	NO
Chromium	35.8	9.2	85.65	MG/KG	ND	18	UG/L	NO	NO
Cobalt	5.2	1	14.88	MG/KG	ND	220	UG/L	NO	NO
Copper	41.6	1.1	31.62	MG/KG	ND	140	UG/L	NO	YES
Cyanide	1.5	ND	NA	MG/KG	ND	75	UG/L	NO	NO
4,4'-DDE	13	6.4	500	UG/KG	ND	0.2	UG/L	NO	NO
4,4'-DDT	23	25	1000	UG/KG	ND	0.2	UG/L	NO	NO
Dibenzofuran	210	ND	12000	UG/KG	ND	15	UG/L	NO	NO
Dieldrin	360	44	1	UG/KG	ND	0.0042	UG/L	NO	YES
Dioxin (TCDD TEQ)	0.8184	1.2986	280	PG/G	ND	0.5	PG/L	NO	NO
Endosulfan II	4	ND	400	UG/KG	ND	22	UG/L	NO	NO
Endrin aldehyde	16	29	400	UG/KG	ND	1.1	UG/L	NO	NO
bis(2-Ethylhexyl)phthalate	1800	ND	11000	UG/KG	ND	4.8	UG/L	NO	NO
Fluoranthene	4200	ND	98000	UG/KG	ND	150	UG/L	NO	NO
Fluorene	660	ND	16000	UG/KG	ND	150	UG/L	NO	NO
Heptachlor	11	ND	60	UG/KG	ND	0.0023	UG/L	NO	NO
Heptachlor epoxide	24	ND	30	UG/KG	ND	0.0012	UG/L	NO	NO
Lead	215	ND	118	MG/KG	ND	15	UG/L	NO	YES
Manganese	382	40.3	1412	MG/KG	578	3391	UG/L	NO	NO
Mercury	0.11	2	3	MG/KG	ND	1.1	UG/L	NO	NO
Methylene chloride	34	29	10	UG/KG	ND	4.1	UG/L	NO	YES
Nickel	12.7	2	33.38	MG/KG	ND	73	UG/L	NO	NO
Phenanthrene	4200	ND	98000	UG/KG	ND	150	UG/L	NO	NO
Pyrene	5300	ND	140000	UG/KG	ND	110	UG/L	NO	NO
Selenium	ND	0.51	3	MG/KG	ND	18	UG/L	NO	NO
Total Petroleum Hydrocarbons	120	120	NA	UG/KG	ND	NA	UG/L	NO	NO
Tetrachloroethene	ND	4.4	40	UG/KG	ND	1.1	UG/L	NO	NO
Toluene	8	5	5000	UG/KG	ND	75	UG/L	NO	NO
Vanadium	43.2	10.2	131.6	MG/KG	10.1	26	UG/L	NO	NO
Zinc	115	7.7	4200	MG/KG	ND	1100	UG/L	NO	NO

* - See Table 5.2-1
ug/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
ng/kg - nanograms per kilogram
ug/L - micrograms per liter
pg/L - picograms per liter
NA - Not available
ND - Not detected

TABLE 5.10.2
Soil-to-Air Volatilization Screening Analysis for AOC 655
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	4.4	62000	MG/KG	NO
2-Butanone	0.019	10000 +	MG/KG	NO
Methylene chloride	0.034	7	MG/KG	NO
Toluene	0.008	520	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentration Tables, March 1995.

+ - Screening value presented for 2-butanone was conservatively estimated at 10,000; actual may be higher.

5.11 AOC 656

AOC 656 is the site of a 1974 oil spill between Buildings 602 and NS-71. This site comprises a grassy area with a bermed AST surrounded by shrubbery. Surface soil, subsurface soil, and groundwater samples were collected at AOC 656. Migration pathways at AOC 656 include soil to groundwater, surface soil to air and groundwater to surface water. Groundwater flow from the area of AOC 656 (based on Figure 3.6) is radial, suggesting AOC 656 is the area of a groundwater high and groundwater flows from this area in all directions. Transport of contaminants by sediment movement or surface water flow are not expected migration pathways due to absence of any surface drainage features and the vegetative cover present over the entire site.

5.11.1 AOC 656 — Soil-to-Groundwater Cross-Media Transport

Table 5.11.1 compares constituent concentrations to groundwater protection SSLs, tap water RBCs, and background UTLs. Screening revealed no constituents detected above the groundwater protection SSLs or the background UTLs. Petroleum hydrocarbons (1,900 mg/kg, TPH) and tin were detected in soil, but in the absence of soil screening levels the soil-to-groundwater quantitative screening was not performed. AOC 656 soil concentrations are protective of the shallow aquifer.

5.11.2 AOC 656 — Groundwater-to-Surface Water Cross-Media Transport

Arsenic and chlorinated dibenzodioxins/dibenzofurans were detected in shallow groundwater at concentrations above their tap water RBCs or background UTLs. Arsenic was detected at a concentration of 60 μg/L in monitoring well NBCH656003, which is above the grid-based background UTL of 27.99 μg/L and the MCL of 50 μg/L. Chlorinated dibenzodioxins/dibenzofurans were detected at a concentration of 1.8 pg/L in monitoring well NBCH656001 which is above the tap water RBC of 0.5 pg/L. Considering soil's neutral to high pH, arsenic is expected precipitate and sorb to the soil matrix rather than migrate in groundwater. Considering a K_{oc} value of 3,300,000, chlorinated dibenzodioxins/dibenzofurans are expected to sorb to the soil matrix rather than migrate in groundwater. AOC 656 has no surface water feature so qualitative screening was not performed for the groundwater-to-surface water migration pathway. The Cooper River, the closest surface water body to AOC 656, will be investigated as part of the Zone J RFI. Groundwater travel time from AOC 656 to the Cooper River is estimated to be 530 years. Based on the predicted travel time to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected.

5.11.3 AOC 656 — Soil-to-Air Cross-Media Transport

No VOCs were detected in surface soil samples at AOC 656.

Table 5.11.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for AOC 656
NAVBASE-Charleston, Zone H

Parameter	Media		Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Water Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or UTL *
Acenaphthene	180	ND	20000	ug/kg	ND	220	ug/L	NO	NO
Acetone	ND	210	800	ug/kg	ND	370	ug/L	NO	NO
Aluminum	17400	12800	46180	mg/kg	672	3700	ug/L	NO	NO
Ammonia	25	250	NA	mg/kg	ND	34	ug/L	NO	NO
Anthracene	250	ND	430000	ug/kg	ND	1100	ug/L	NO	NO
Arsenic	14.8	14.2	35.52	mg/kg	60	27.99	ug/L	YES	NO
Barium	25.8	20.7	43.8	mg/kg	83	323	ug/L	NO	NO
Benzo(g,h,i)perylene	127	ND	98000	ug/kg	ND	150	ug/L	NO	NO
Benzo(a)pyrene Equivalents	208.164	0.23	4000	ug/kg	ND	0.0092	ug/L	NO	NO
Beryllium	0.92	0.89	180	mg/kg	ND	0.016	ug/L	NO	NO
alpha-Chlordane	6	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
gamma-Chlordane	6	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
Chromium	41.8	33.7	85.65	mg/kg	2	18	ug/L	NO	NO
Cobalt	5.5	4.8	14.88	mg/kg	ND	220	ug/L	NO	NO
Copper	27.8	16.5	31.62	mg/kg	ND	140	ug/L	NO	NO
4,4'-DDD	ND	6	700	ug/kg	ND	0.28	ug/L	NO	NO
4,4'-DDE	5	3	500	ug/kg	ND	0.2	ug/L	NO	NO
4,4'-DDT	2.7	ND	1000	ug/kg	ND	0.2	ug/L	NO	NO
Dioxin (TCDD TEQ)	4.5767	ND	280	ng/kg	1.7471	0.5	pg/L	YES	NO
Endosulfan II	3.2	ND	400	ug/kg	ND	22	ug/L	NO	NO
bis(2-Ethylhexyl)phthalate	280	ND	11000	ug/kg	ND	4.8	ug/L	NO	NO
Fluoranthene	400	110	98000	ug/kg	ND	150	ug/L	NO	NO
Fluorene	ND	270	16000	ug/kg	ND	150	ug/L	NO	NO
Lead	40	30.6	118	mg/kg	1.9	15	ug/L	NO	NO
Manganese	719	579	1412	mg/kg	835	3391	ug/L	NO	NO
Mercury	0.26	0.14	3	mg/kg	ND	1.1	ug/L	NO	NO
Nickel	12.8	ND	33.38	mg/kg	27.5	73	ug/L	NO	NO
Phenanthrene	320	780	98000	ug/kg	ND	150	ug/L	NO	NO
Pyrene	290	280	140000	ug/kg	ND	110	ug/L	NO	NO
Selenium	0.72	1	3	mg/kg	4.2	18	ug/L	NO	NO
2,4,5-TP (Silvex)	7.3	ND	1580	ug/kg	ND	1580	ug/L	NO	NO
Thallium	ND	ND	1.3	mg/kg	4.1	7.66	ug/L	NO	NO
Total Petroleum Hydrocarbons	1900	ND	NA	ug/kg	ND	NA	ug/L	NO	NO
Tin	5.8	ND	NA	mg/kg	ND	2200	ug/L	NO	NO
Vanadium	56.1	51.8	131.6	mg/kg	11.6	26	ug/L	NO	NO
Zinc	141	58.9	4200	mg/kg	18.5	1100	ug/L	NO	NO

* - See Table 5.2.1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected

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5.12 AOC 659

AOC 659 is a grass-covered site which contains a 30,000-gallon steel AST, that stored diesel fuel from 1958 until 1990. The tank is surrounded by a 5-foot-high earthen berm. Surface soil and subsurface soil samples were collected for AOC 659. Migration pathways for AOC 659 include soil to groundwater, surface soil to air, and groundwater to surface water. No contaminant migration by sediment and/or surface water movement is expected due to the berm surrounding the AST.

5.12.1 AOC 659 — Soil-to-Groundwater Cross-Media Transport

Dieldrin, methylene chloride, 2-methylnaphthalene and naphthalene were detected in soil at concentrations above the groundwater protection SSLs. Based on review of blank data associated with soil sampling activities during the AOC 659 RFI, detections of methylene chloride in soil are suspect. The concentrations of the remaining constituents are only marginally above their respective groundwater protection SSLs. These findings indicate that no significant impact to the shallow aquifer exists for AOC 659 soil concentrations. Petroleum hydrocarbons and tin were detected in soil, but in the absence of SSLs for these constituents, the soil-to-groundwater quantitative screening was not performed. At the concentrations reported, neither petroleum hydrocarbons nor tin would be expected to significantly threaten the shallow aquifer underlying AOC 659.

5.12.2 AOC 659 — Groundwater-to-Surface Water Cross-Media Transport

No threat exists to the Cooper River as soil constituent concentrations are considered protective of the shallow aquifer.

5.12.3 AOC 659 — Soil-to-Air Cross-Media Transport

Table 5.12.2 lists the VOCs detected in surface soil samples collected at AOC 659, along with corresponding soil-to-air volatilization screening levels. No VOC's maximum surface soil concentration compound exceeded its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.12.1
Chemicals Detected in Soil
Comparison to Groundwater Protection Soil Screening Levels for AOC 659
NAVBASE-Charleston, Zone H

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil Maximum Conc.	Ground Water Protection SSL or UTL *	Soil Units	Soil Exceeds SSL or UTL
Acenaphthene	ND	49.4	20000	ug/kg	NO
Acetone	8.75	71.1	800	ug/kg	NO
Aluminum	6870	3560	46180	mg/kg	NO
Arsenic	2.3	1.9	35.52	mg/kg	NO
Barium	8.6	11.1	43.8	mg/kg	NO
Benzo(a)pyrene Equivalents	ND	14.41	4000	ug/kg	NO
Beryllium	0.21	0.2	180	mg/kg	NO
Cadmium	0.22	ND	6	mg/kg	NO
alpha-Chlordane	1.3	ND	2000	ug/kg	NO
gamma-Chlordane	10	ND	2000	ug/kg	NO
Chromium	18.4	6.6	85.65	mg/kg	NO
Cobalt	1	1.3	14.88	mg/kg	NO
4,4'-DDD	ND	50.2	700	ug/kg	NO
4,4'-DDE	ND	103	500	ug/kg	NO
4,4'-DDT	3.6	ND	1000	ug/kg	NO
Dibenzofuran	ND	3510	12000	ug/kg	NO
Di-n-butylphthalate	52	ND	12000	ug/kg	NO
Dieldrin	2.7	ND	1	ug/kg	YES
Dioxin (TCDD TEQ)	0.73	ND	280	ng/kg	NO
Endosulfan sulfate	2.4	ND	400	ug/kg	NO
Ethylbenzene	ND	2660	5000	ug/kg	NO
bis(2-Ethylhexyl)phthalate	423	ND	11000	ug/kg	NO
Fluoranthene	ND	345	98000	ug/kg	NO
Lead	12.1	3.5	118	mg/kg	NO
Manganese	38.7	34.4	1412	mg/kg	NO
Methylene chloride	ND	328	10	ug/kg	YES
2-Methylnaphthalene	ND	11100	3000	ug/kg	YES
Mercury	0.08	ND	3	mg/kg	NO
Naphthalene	ND	5150	3000	ug/kg	YES
Nickel	0.77	ND	33.38	mg/kg	NO
Phenanthrene	ND	3212	98000	ug/kg	NO
Pyrene	ND	428	140000	ug/kg	NO
2,4,5-T	9	ND	260	ug/kg	NO
2,4,5-TP	9.1	ND	1580	ug/kg	NO
Tin	1.5	ND	NA	mg/kg	NO
Total Petroleum Hydrocarbons	180	18000	NA	ug/kg	NO
Toluene	1.5	395	5000	ug/kg	NO
Vanadium	16.6	8.3	131.6	mg/kg	NO
Zinc	30.7	ND	4200	mg/kg	NO

* - See table 5.2.1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected

TABLE 5.12.2
Soil-to-Air Volatilization Screening Analysis for AOC 659
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.00875	62000	MG/K	NO
Toluene	0.0015	520	MG/K	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrati
Tables, March 1995.

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5.13 AOC 660

AOC 660 is an area that was used to mix and rinse pesticides associated with mosquito control in the 1950s. The area of AOC 660 is completely covered with asphalt. Migration of constituents in the soil of AOC 660 is not expected due to the asphalt cover; however the soil-to-groundwater, surface soil-to-air and groundwater to surface water migration pathways are evaluated on a screening level. Surface soil, subsurface soil, and groundwater were sampled at AOC 660.

5.13.1 AOC 660 — Soil-to-Groundwater Cross-Media Transport

Table 5.13.1 compares constituents concentrations to groundwater protection SSLs, tap water RBCs, and background UTLs. Toxaphene was detected in one surface soil sample at concentrations marginally exceeding a conservative groundwater protection SSL. Toxaphene was not detected in AOC 660 shallow groundwater. Tin was detected in soil, but in the absence of an SSL soil-to-groundwater quantitative screening was not performed. No constituents detected in AOC 660 soil were detected in excess of the tap water RBCs or background UTLs in AOC 660 shallow groundwater. This indicates that AOC 660 soil is protective of the shallow aquifer.

5.13.2 AOC 660 — Groundwater to Surface Water Cross-Media Transport

Groundwater travel time from AOC 660 to the Cooper River is estimated to be 49 years. Based on the limited impact to AOC 660 shallow groundwater, the predicted travel time to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected.

5.13.3 AOC 660 — Soil-to-Air Cross-Media Transport

Table 5.13.2 lists the VOCs detected in surface soil samples collected at AOC 660, along with corresponding soil-to-air volatilization screening levels. No VOC's surface soil concentration compound exceeded its corresponding soil-to-air volatilization screening level. A conservative soil-to-air screening value of 10,000 mg/kg was used for 2-butanone. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.13.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for AOC 660
NAVBASE-Charleston, Zone H

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil Maximum Conc.	Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Water Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or UTL
Acetone	73.7	ND	800	ug/kg	ND	370	ug/L	NO	NO
Aluminum	9550	3070	46180	mg/kg	1940	3700	ug/L	NO	NO
Arsenic	1.6	ND	35.52	mg/kg	12.8	27.99	ug/L	NO	NO
Barium	20	ND	43.8	mg/kg	17.8	323	ug/L	NO	NO
Beryllium	0.45	ND	180	mg/kg	ND	0.016	ug/L	NO	NO
2-Butanone (MEK)	4.1	12	570	ug/kg	ND	190	ug/L	NO	NO
alpha-Chlordane	4	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
gamma-Chlordane	4	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
Chromium	9.6	ND	85.65	mg/kg	2.75	18	ug/L	NO	NO
Cobalt	4.9	ND	14.88	mg/kg	ND	220	ug/L	NO	NO
Copper	4.4	1.3	140	mg/kg	ND	140	ug/L	NO	NO
4,4'-DDD	12	ND	700	ug/kg	ND	0.28	ug/L	NO	NO
4,4'-DDE	62	2	500	ug/kg	ND	0.2	ug/L	NO	NO
4,4'-DDT	12	ND	1000	ug/kg	ND	0.2	ug/L	NO	NO
Dioxin (TCDD TEQ)	2.6115	ND	280	ng/kg	ND	0.5	pg/L	NO	NO
Endrin aldehyde	7	ND	400	ug/kg	ND	11	ug/L	NO	NO
Heptachlor	4	ND	60	ug/kg	ND	0.0023	ug/L	NO	NO
Lead	27	ND	118	mg/kg	3	15	ug/L	NO	NO
Manganese	73	ND	1412	mg/kg	108	3391	ug/L	NO	NO
Mercury	0.12	ND	3	mg/kg	ND	1.1	ug/L	NO	NO
Nickel	1.4	ND	33.38	mg/kg	ND	73	ug/L	NO	NO
Selenium	0.4	ND	3	mg/kg	5.9	18	ug/L	NO	NO
Silver	ND	ND	NA	mg/kg	3.5	18	ug/L	NO	NO
2,4,5-TP (Silvex)	8.6	ND	1580	ug/kg	ND	29	ug/L	NO	NO
Thallium	0.35	ND	1.3	mg/kg	ND	7.66	ug/L	NO	NO
Tin	2.9	ND	NA	mg/kg	ND	2200	ug/L	NO	NO
Toluene	9	6	5000	ug/kg	ND	75	ug/L	NO	NO
Toxaphene	100	ND	40	ug/kg	ND	0.061	ug/L	NO	YES
Vanadium	11.4	ND	131.6	mg/kg	7.6	26	ug/L	NO	NO
Zinc	ND	ND	4200	mg/kg	9.3	1100	ug/L	NO	NO

* - See Table 5.2.1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected

TABLE 5.13.2
Soil-to-Air Volatilization Screening Analysis for AOC 660
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.0737	62000	MG/KG	NO
2-Butanone	0.0041	10000 +	MG/KG	NO
Toluene	0.009	520	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrati
Tables, March 1995.

+ - Screening value presented for 2-butanone was conservatively estimated at
10,000; actual may be higher.

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5.14 AOC 662

AOC 662, formerly a gasoline service station and a billeting office, has two remaining steel USTs. The area around the UST surface pad is paved with concrete and asphalt. Migration pathways for AOC 662 include soil to groundwater, surface soil to air, and groundwater to surface water. Contaminant movement by sediment and/or surface water flow is not likely due to the coverage of asphalt and concrete. Surface soil, subsurface soil, and groundwater were sampled at AOC 662.

5.14.1 AOC 662 — Soil-to-Groundwater Cross-Media Transport

Table 5.14.1 compares constituent concentrations to groundwater protection SSLs, tap water RBCs, and background UTLs. Cobalt was detected in soil at concentrations exceeding the background UTL in a single soil sample. Cobalt was not detected in AOC 662 shallow groundwater. No constituents were detected in AOC 662 shallow groundwater above the tap water RBCs. AOC 662 soil does not present a threat to the shallow aquifer.

5.14.2 AOC 662 — Groundwater-to-Surface Water Cross-Media Transport

Groundwater travel time from AOC 662 to the Cooper River is estimated to be 200 years. Based on the limited impact to AOC 662 shallow groundwater, the predicted travel time to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected.

5.14.3 AOC 662 — Soil-to-Air Cross-Media Transport

Table 5.14.2 lists the VOC (acetone) detected in surface soil samples collected at AOC 662, along with its corresponding soil-to-air volatilization screening level. The maximum surface soil concentration of acetone does not exceed its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.14.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for AOC 662
NAVBASE-Charleston, Zone H

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil Maximum Conc.	Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Water Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or UTL
Acetone	33	79	800	ug/kg	ND	370	ug/L	NO	NO
Aluminum	3450	4330	46180	mg/kg	ND	3700	ug/L	NO	NO
Antimony	2.2	ND	NA	mg/kg	ND	1.5	ug/L	NO	NO
Arsenic	6.8	7.8	35.52	mg/kg	ND	27.99	ug/L	NO	NO
Barium	23.9	24.7	43.8	mg/kg	29.6	323	ug/L	NO	NO
Benzo(a)pyrene Equivalents	64.4268	ND	4000	ug/kg	ND	0.0092	ug/L	NO	NO
Beryllium	0.66	0.68	180	mg/kg	ND	0.016	ug/L	NO	NO
Cadmium	0.33	0.39	6	mg/kg	ND	1.8	ug/L	NO	NO
Chromium	20.8	31.7	85.65	mg/kg	ND	18	ug/L	NO	NO
Cobalt	12.9	22.1	14.88	mg/kg	ND	220	ug/L	NO	YES
Copper	2.6	2.7	31.62	mg/kg	ND	140	ug/L	NO	NO
4,4'-DDE	4	6	500	ug/kg	ND	0.2	ug/L	NO	NO
4,4'-DDT	3.7	ND	1000	ug/kg	ND	0.2	ug/L	NO	NO
Dioxin (TCDD TEQ)	0.6616	ND	280	ng/kg	ND	0.5	pg/L	NO	NO
Fluoranthene	63.1	ND	98000	ug/kg	ND	150	ug/L	NO	NO
Lead	4.3	6.2	118	mg/kg	2	15	ug/L	NO	NO
Manganese	58.6	88.9	1412	mg/kg	629	3391	ug/L	NO	NO
Mercury	0.02	ND	3	mg/kg	ND	1.1	ug/L	NO	NO
Nickel	8	12.1	33.38	mg/kg	ND	73	ug/L	NO	NO
Pyrene	93	ND	140000	ug/kg	ND	110	ug/L	NO	NO
Selenium	0.96	1.5	3	mg/kg	ND	18	ug/L	NO	NO
Vanadium	17.1	18.6	131.6	mg/kg	3.2	26	ug/L	NO	NO
Zinc	15.3	38.9	4200	mg/kg	ND	1100	ug/L	NO	NO

* - See Table 5.2.1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/l - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected

TABLE 5.14.2
Soil-to-Air Volatilization Screening Analysis for AOC 662
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.033	62000	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrati
Tables, March 1995.

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5.15 AOC 663 (Includes SWMU 136)

AOC 663 is a diesel pumping station at Building 851 with two 500-gallon USTs and five flammable-storage lockers. SWMU 136 is an SAA that receives hazardous waste from Buildings 851 and NS-53. The vicinity of these two sites is relatively flat and has asphalt/concrete and grass-covered areas. Migration pathways for AOC 663 include soil to groundwater, soil to air, and groundwater to surface water. Transport of contaminants by sediment and/or surface water movement is not likely given the nature of the area's cover and the absence of any distinct drainage feature. Surface soil, subsurface soil, and groundwater samples were collected at AOC 663.

5.15.1 AOC 663 — Soil-to-Groundwater Cross-Media Transport

Table 5.15.1 compares constituent concentrations to groundwater protection SSLs, tap water RBCs, and background UTLs. Screening identified no constituents above the groundwater protection SSLs, the tap water RBCs, and/or the grid-based background UTLs in both soil and groundwater. Benzo(a)anthracene, benzo(b)fluoranthene, chrysene, cadmium, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, heptachlor epoxide, and methylene chloride were detected in combined AOC 663 soil above the groundwater protection SSLs in only one soil sample each and were not detected in groundwater. The limited extent of impacts to soil suggest that soil to groundwater migration is unlikely to be a significant process. Petroleum hydrocarbons (190 mg/kg, TPH), and tin were detected in soil, but in the absence of SSLs for these constituents, the soil-to-groundwater quantitative screening was not performed. Presently no concentrations of petroleum hydrocarbons or tin have been detected in the shallow groundwater.

5.15.2 AOC 663 — Groundwater-to-Surface Water Cross-Media Transport

Chlorinated dibenzodioxins/dibenzofurans and benzene were detected in shallow groundwater at concentration above the tap water RBCs. Chlorinated dibenzodioxins/dibenzofurans were detected at a concentration of 1.3 pg/L, which is above the tap water RBC of 0.5 pg/L. Benzene was detected in groundwater (second quarter only) at a concentration of 160 μg/L which is above the tap water RBC of 0.36 μg/L. Considering a K_{oc} value of 3,300,000, chlorinated dibenzodioxins/dibenzofurans are expected to sorb to the soil matrix rather than migrate in groundwater. Benzene, however, is more mobile in groundwater with a lower K_{oc} value (50). Groundwater concentrations of benzene cannot be directly related to a potential AOC 663 surface of subsurface soil source. It should be noted that AOC 663 is a diesel fuel pumping station which has the potential to release petroleum-related compounds such as benzene. Considering the detection of benzene in the second-quarter groundwater only, risk management decisions based on migration of groundwater benzene concentrations should be deferred until the third and fourth groundwater results have been evaluated. Groundwater travel time from AOC 663 to the Cooper River is estimated to be 107 years. Applying a retardation factor for benzene, the travel time is estimated to be 897 years. Based on the predicted travel time to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected.

5.15.3 AOC 663 — Soil-to-Air Cross-Media Transport

Table 5.15.2 lists the VOC (methylene chloride) detected in surface soil samples collected at AOC 663 along with its corresponding soil-to-air volatilization screening level. The maximum surface soil concentration of methylene chloride does not exceed its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway would not be expected to be significant at the site. No VOCs were detected in surface soil samples at SWMU 136.

Table 5.15.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for AOC 663 and SWMU 136
NAVBASE-Charleston, Zone H

Parameter	Media		Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Water Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or SSL
Acenaphthylene	1600	ND	20000	ug/kg	ND	220	ug/L	NO	NO
Acetone	ND	46.4	800	ug/kg	ND	370	ug/L	NO	NO
Aluminum	31900	6610	46180	mg/kg	1700	3700	ug/L	NO	NO
Ammonia	31	31	NA	mg/kg	ND	34	ug/L	NO	NO
Anthracene	2200	ND	430000	mg/kg	ND	1100	ug/L	NO	NO
Aroclor-1254	695	ND	8200	ug/kg	ND	0.0087	ug/L	NO	NO
Arsenic	23.9	7.1	35.52	mg/kg	10.8	27.99	ug/L	NO	NO
delta-BHC	4	ND	6	mg/kg	ND	0.052	ug/L	NO	NO
Barium	29.9	12.6	43.8	mg/kg	21.5	323	ug/L	NO	NO
Benzene	ND	ND	20	ug/kg	160	0.36	ug/L	YES	NO
Benzo(g,h,i)perylene	780	ND	98000	ug/kg	ND	150	ug/L	NO	NO
Benzo(a)pyrene	3200	ND	4000	ug/kg	ND	0.0092	ug/L	NO	NO
Benzo(a)anthracene	1400	ND	700	ug/kg	ND	0.092	ug/L	NO	YES
Benzo(b)fluoranthene	6300	57.5	4000	ug/kg	ND	0.092	ug/L	NO	YES
Benzo(k)fluoranthene	212	ND	4000	ug/kg	ND	0.92	ug/L	NO	NO
Chrysene	3500	ND	1000	ug/kg	ND	9.2	ug/L	NO	YES
Dibenzo(a,h)anthracene	350	ND	11000	ug/kg	ND	0.092	ug/L	NO	NO
Indeno(1,2,3-cd)pryene	980	ND	35000	ug/kg	ND	0.0092	ug/L	NO	NO
Beryllium	1.4	0.55	180	mg/kg	ND	0.016	ug/L	NO	NO
Cadmium	7.4	0.31	6	mg/kg	ND	1.8	ug/L	NO	YES
alpha-Chlordane	389	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
gamma-Chlordane	423	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
Chromium	54.3	14.3	85.65	mg/kg	ND	18	ug/L	NO	NO
Cobalt	8.3	2.8	14.8	mg/kg	ND	220	ug/L	NO	NO
Copper	31.5	1.7	31.62	mg/kg	ND	140	ug/L	NO	NO
2,4-DB	ND	ND	NA	ug/kg	1.6	29	ug/L	NO	NO
4,4'-DDD	1940	ND	700	ug/kg	ND	0.28	ug/L	NO	YES
4,4'-DDE	4480	ND	500	ug/kg	ND	0.2	ug/L	NO	YES
4,4'-DDT	1390	ND	1000	ug/kg	ND	0.2	ug/L	NO	YES
Di-n-butylphthalate	40.9	45.2	12000	ug/kg	ND	370	ug/L	NO	NO
Dioxin (TCDD TEQ)	4.9299	ND	280	ng/kg	1.3289	0.5	pg/L	YES	NO
Endosulfan I	10	ND	400	ug/kg	ND	22	ug/L	NO	NO
Endrin	7.95	ND	400	ug/kg	ND	1.1	ug/L	NO	NO
Ethylbenzene	ND	ND	5000	ug/kg	19	130	ug/L	NO	NO
bis(2-Ethylhexyl)phthalate	904	159	11000	ug/kg	ND	4.8	ug/L	NO	NO
Fluoranthene	1970	210	98000	ug/kg	ND	150	ug/L	NO	NO
Fluorene	160	ND	16000	ug/kg	ND	150	ug/L	NO	NO
Heptachlor epoxide	31.1	ND	30	ug/kg	ND	0.0012	ug/L	NO	YES
Lead	118	16.5	118	mg/kg	2.9	15	ug/L	NO	NO
Manganese	826	157	1412	mg/kg	548	3391	ug/L	NO	NO
Mercury	0.19	ND	3	mg/kg	ND	1.1	ug/L	NO	NO
Methylene chloride	11.2	ND	10	ug/kg	ND	4.1	ug/L	NO	YES
Nickel	17.1	4.2	33.38	mg/kg	ND	73	ug/L	NO	NO

Table 5.15.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for AOC 663 and SWMU 136
NAVBASE-Charleston, Zone H

Parameter	Media		Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Water Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or SSL
Phenanthrene	608	ND	98000	ug/kg	ND	150	ug/L	NO	NO
Phenol	ND	ND	4900	ug/kg	7.2	2200	ug/L	NO	NO
Pyrene	3400	140	140000	ug/kg	ND	110	ug/L	NO	NO
Selenium	0.51	0.41	3	mg/kg	3.9	18	ug/L	NO	NO
2,4,5-TP (Silvex)	7.3	ND	1580	ug/kg	ND	29	ug/L	NO	NO
Toluene	ND	ND	5000	ug/kg	37	75	ug/L	NO	NO
Total Petroleum Hydrocarbons	190	ND	NA	ug/kg	ND	NA	ug/L	NO	NO
Tin	2	ND	NA	mg/kg	ND	2200	ug/L	NO	NO
Vanadium	84.5	17.7	131.6	mg/kg	7	26	ug/L	NO	NO
Xylene (total)	ND	ND	74000	ug/kg	26	1200	ug/L	NO	NO
Zinc	816	40.8	4200	mg/kg	10.6	1100	ug/L	NO	NO

* - See Table 5.2.1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not available

TABLE 5.15.2
Soil-to-Air Volatilization Screening Analysis for AOC 663 and SWMU 136
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Methylene chloride	0.0112	7	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrati
Tables, March 1995.

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5.16 AOC 665

AOC 665 stored unknown pyrotechnics from 1943 until the shed was demolished at an unknown date. Most of AOC 665 is paved or covered with buildings. A small area, covered with grass or gravel, is present around Building 1889, which is thought to represent the approximate location of the former pyrotechnics shed. Surface soil and subsurface soil samples were collected as part of the AOC 665 RFI. Migration pathways for AOC 665 include soil to groundwater and groundwater to surface soil. Transport of contaminants by sediment and/or surface water movement is not likely given the impermeable and grassy covers over the area and the absence of any distinct drainage feature.

5.16.1 AOC 665 — Soil-to-Groundwater Cross-Media Transport

Table 5.16.1, identified copper in soil at a concentration marginally above the grid-based background UTL. These findings indicate that no impact to the shallow aquifer is likely from AOC 665 soil concentrations. Petroleum hydrocarbons and tin were detected in soil, but in the absence of SSLs for these constituents, the soil-to-groundwater quantitative screening was not performed.

5.16.2 AOC 665 Groundwater-to-Surface Water Cross-Media Transport

Groundwater travel time from AOC 665 to the Cooper River is estimated to be 252 years. Based AOC 665 soil results, no shallow aquifer impacts would be expected. Furthermore, any minor localized groundwater effects would not threaten surface water based on the predicted travel time to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream.

5.16.3 AOC 665 — Soil-to-Air Cross-Media Transport

Table 5.16.2 lists the VOCs detected in surface soil samples collected at AOC 665 along with corresponding soil-to-air volatilization screening levels. No VOC's surface soil concentration exceeded its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.16.1
Chemicals Detected in Soil
Comparison to Groundwater Protection Soil Screening Levels for AOC 665
NAVBASE-Charleston, Zone H

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil Maximum Conc.	Ground Water Protection SSL or UTL *	Soil Units	Soil Exceeds SSL or UTL
Acetone	210	96	800	ug/kg	NO
Aluminum	8000	2830	46180	mg/kg	NO
Ammonia	20	5	NA	mg/kg	NO
Anthracene	150	ND	430000	ug/kg	NO
Antimony	ND	1.4	NA	mg/kg	NO
Arsenic	7.9	9	35.52	mg/kg	NO
Barium	14.1	5.1	43.8	mg/kg	NO
Benzo(g,h,i)perylene	100	ND	98000	ug/kg	NO
Benzo(a)pyrene Equivalents	150.67	ND	4000	ug/kg	NO
Beryllium	0.24	0.31	180	mg/kg	NO
Cadmium	0.81	0.19	6	mg/kg	NO
alpha-Chlordane	11	670	2000	ug/kg	NO
gamma-Chlordane	18	650	2000	ug/kg	NO
Chromium	17.4	20.7	85.65	mg/kg	NO
Cobalt	1.6	1	14.88	mg/kg	NO
Copper	39.1	10.2	31.62	mg/kg	YES
4,4'-DDE	8	3	500	ug/kg	NO
4,4'-DDT	13	ND	1000	ug/kg	NO
Dioxin (TCDD TEQ)	ND	0.5709	280	ng/kg	NO
Endosulfan I	ND	140	400	ug/kg	NO
Endosulfan II	4	ND	400	ug/kg	NO
bis(2-Ethylhexyl)phthalate (BE	130	150	11000	ug/kg	NO
Fluoranthene	370	ND	98000	ug/kg	NO
Heptachlor epoxide	8	ND	60	ug/kg	NO
Lead	51.4	5.3	118	mg/kg	NO
Manganese	63.9	135	1412	mg/kg	NO
Mercury	0.1	0.05	3	mg/kg	NO
Nickel	10.1	6.4	33.38	mg/kg	NO
Phenanthrene	320	ND	98000	ug/kg	NO
Pyrene	280	ND	140000	ug/kg	NO
Tin	ND	2.2	NA	mg/kg	NO
Total Petroleum Hydrocarbons (	200	ND	NA	ug/kg	NO
Toluene	4.2	10	5000	ug/kg	NO
Vanadium	36.9	15.5	131.6	mg/kg	NO
Zinc	111	34.5	4200	mg/kg	NO

* - See table 5.2.1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per kilogram or picogram per kilogram
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected

TABLE 5.16.2
Soil-to-Air Volatilization Screening Analysis for AOC 665
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.21	62000	MG/KG	NO
Toluene	0.0042	520	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrati
Tables, March 1995.

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5.17 AOC 666

AOC 660 is a UST (NS-45) that supplies fuel oil to the adjacent heating plant (NS-44). The site is a flat area covered with grass and gravel. Migration pathways for AOC 666 include soil to groundwater and groundwater to surface water. Transport of contaminants by sediment and/or surface water movement is not likely given the primarily grassy cover and absence of any distinct drainage feature in the vicinity. Surface soil, subsurface soil, and groundwater samples were collected from AOC 666.

5.17.1 AOC 666 — Soil-to-Groundwater Cross-Media Transport

Table 5.17.1 compares constituent concentrations to groundwater protection SSLs, tap water RBCs, and background UTLs. 2-Chlorophenol, copper, 2,4-dinitrotoluene, nickel, N-nitroso-di-n-propylamine, pentachlorophenol, 2,4,6-trichlorophenol, and vanadium were detected in soil at concentrations above the groundwater protection SSLs or background UTLs. Antimony, 4-chloro-3-methylphenol, cyanide and petroleum hydrocarbons (30,000 mg/kg, TPH) were detected in soil, but in the absence of a SSLs for these constituents, the soil-to-groundwater quantitative screening was not performed. The concentrations of 4-chloro-3-methylphenol and TPH would suggest a threat to the shallow aquifer, but neither was detected in AOC 666 groundwater samples. Of the constituents detected in soil above the groundwater protection SSLs, only nickel and vanadium were detected in the shallow aquifer. Nickel and vanadium were not detected in groundwater above the tap water RBCs. 2-Chlorophenol, 2,4-dinitrotoluene, N-nitroso-di-n-propylamine, pentachlorophenol, and 2,4,6-trichlorophenol were detected above the groundwater protection SSLs in only one soil sample each. The limited impacts of these constituents suggest that soil to groundwater migration is not likely to be a significant process. These findings indicate that AOC 666 soil is protective of the shallow aquifer.

5.17.2 AOC 666 — Groundwater-to-Surface Water Cross-Media Transport

Chloromethane and vinyl chloride were detected in monitoring well NBCH660001 at concentrations above their tap water RBCs in the first-quarter samples only. Chloromethane was detected at a concentration of 6 μg/L which is above the tap water RBC of 1.4 μg/L and vinyl chloride was detected at a concentrations of 2.1 μg/L, which is above the tap water RBC of 0.019 μg/L. AOC 666 has no surface water feature. qualitative screening was not performed for the groundwater-to-surface water migration pathway. Shipyard Creek, the closest surface water body to AOC 666, will be investigated as part of the Zone J RFI. Groundwater travel time from AOC 666 to Shipyard Creek is estimated to be 1,000 years. Applying a retardation factor for vinyl chloride, the most mobile of the contaminants in AOC 666 groundwater, the predicted travel time to Shipyard Creek is 1,200 years. Based on the predicted travel time to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected.

5.17.3 AOC 666 — Soil-to-Air Cross-Media Transport

Table 5.17.2 lists the VOCs detected in surface soil samples collected at AOC 666, along with corresponding soil-to-air volatilization screening levels. No VOC's surface soil concentration exceeded its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.17.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for AOC 666
NAVBASE-Charleston, Zone H

Parameter	Surface Soil Maximum Conc.	Sub-surface Soil Maximum Conc.	Ground Water Protection SSL or UTL *	Soil Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Water Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or UTL
Acenaphthene	380	ND	20000	ug/kg	14	220	ug/L	NO	NO
Acetone	ND	9.64	800	ug/kg	ND	370	ug/L	NO	NO
Aluminum	6960	7580	46180	mg/kg	ND	3700	ug/L	NO	NO
Antimony	2	2.3	NA	mg/kg	ND	1.5	ug/L	NO	NO
Aroclor-1260	88.4	ND	8200	ug/kg	ND	0.0087	ug/L	NO	NO
Arsenic	30.5	4.7	35.52	mg/kg	6.2	27.99	ug/L	NO	NO
Barium	30.4	5.3	43.8	mg/kg	53.6	323	ug/L	NO	NO
Benzo(g,h,i)perylene	166	ND	98000	ug/kg	ND	150	ug/L	NO	NO
Benzo(a)pyrene Equivalents	1469.83	1750	4000	ug/kg	ND	0.0092	ug/L	NO	NO
Beryllium	0.2	0.22	180	mg/kg	ND	0.016	ug/L	NO	NO
Butylbenzylphthalate	57.8	ND	6800	ug/kg	ND	730	ug/L	NO	NO
Cadmium	0.71	0.16	6	mg/kg	ND	1.8	ug/L	NO	NO
gamma-Chlordane	8.9	ND	2000	ug/kg	ND	0.052	ug/L	NO	NO
Chloromethane	ND	ND	6.6	ug/kg	6	1.4	ug/L	YES	NO
4-Chloro-3-methylphenol	380	ND	NA	ug/kg	ND	NA	ug/L	NO	NO
2-Chlorophenol	3800	ND	200	ug/kg	ND	18	ug/L	NO	YES
Chromium	35.1	18.2	85.65	mg/kg	ND	18	ug/L	NO	NO
Cobalt	2.2	1.3	14.88	mg/kg	ND	220	ug/L	NO	NO
Copper	138	115	31.62	mg/kg	ND	140	ug/L	NO	YES
Cyanide	ND	1	NA	mg/kg	ND	75	ug/L	NO	NO
Di-n-butylphthalate	567	587	12000	ug/kg	ND	370	ug/L	NO	NO
1,4-Dichlorobenzene	380	ND	1000	ug/kg	ND	0.44	ug/L	NO	NO
Diethylphthalate	ND	84	11000	ug/kg	ND	2900	ug/L	NO	NO
2,4-Dinitrotoluene	380	ND	20	ug/kg	ND	7.3	ug/L	NO	YES
Di-n-octylphthalate	ND	466	1E+08	ug/kg	ND	73	ug/L	NO	NO
Dioxin (TCDD TEQ)	5.42	ND	280	ng/kg	ND	0.5	pg/L	NO	NO
bis(2-Ethylhexyl)phthalate	116	137	11000	ug/kg	ND	4.8	ug/L	NO	NO
Fluoranthene	5690	120	980000	ug/kg	ND	150	ug/L	NO	NO
Lead	118	5.8	118	mg/kg	1.3	15	ug/L	NO	NO
Manganese	78.2	39	1412	mg/kg	102	3391	ug/L	NO	NO
Mercury	2.3	0.05	3	mg/kg	ND	1.1	ug/L	NO	NO
Nickel	39.3	9	33.38	mg/kg	21.8	73	ug/L	NO	YES
4-Nitrophenol	380	ND	1670	ug/kg	ND	230	ug/L	NO	NO
N-Nitroso-di-n-propylamine	380	ND	0.02	ug/kg	ND	0.0096	ug/L	NO	YES
Pentachlorophenol	380	ND	200	ug/kg	ND	0.56	ug/L	NO	YES
Phenanthrene	1080	ND	98000	ug/kg	ND	150	ug/L	NO	NO
Phenol	380	ND	4900	ug/kg	ND	2200	ug/L	NO	NO
Pyrene	4320	98	140000	ug/kg	ND	110	ug/L	NO	NO
Selenium	0.62	1	3	mg/kg	3.4	18	ug/L	NO	NO
Total Petroleum Hydrocarbons	3000	16000	NA	mg/kg	ND	NA	ug/L	NO	NO
Toluene	14	10	5000	ug/kg	ND	75	ug/L	NO	NO
1,2,4-Trichlorobenzene	380	ND	2000	ug/kg	ND	19	ug/L	NO	NO
2,4,6-Trichlorophenol	ND	430	50	ug/kg	ND	6.1	ug/L	NO	YES
Vanadium	275	136	131.6	mg/kg	8.4	26	ug/L	NO	YES
Vinyl chloride	ND	ND	10	ug/kg	2.1	0.019	ug/L	YES	NO
Zinc	285	21.7	4200	mg/kg	9.6	1100	ug/L	NO	NO

* - See Table 5.2.1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected

TABLE 5.17.2
Soil-to-Air Volatilization Screening Analysis for AOC 666
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentratio in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
1,4-Dichlorobenzene	0.21	7700	MG/KG	NO
Toluene	0.014	520	MG/KG	NO
1,2,4-Trichlorobenzene	0.38	240	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentrati
Tables, March 1995.

5.18 AOC 667 (Includes SWMU 138)

AOC 667, the vehicle maintenance area, is a two-story brick structure (Building 1776) with an oil/water separator. SWMU 138, the SAA related to Building 1776, stores hazardous waste in 55-gallon drums which are immediately transferred to a permitted hazardous waste storage facility. The entire area of SWMU 138 and AOC 667 is paved. Migration pathways for AOC 667 include soil to groundwater and groundwater to surface water. Transport of contaminants by sediment and/or surface water movement is not likely given the impermeable cover over the area and the absence of any distinct drainage feature. Surface soil, subsurface soil, and groundwater samples were collected at AOC 667/SWMU 138.

5.18.1 AOC 667 — Soil-to-Groundwater Cross-Media Transport

Table 5.18.1 compares constituent concentrations to groundwater protection SSLs, tap water RBCs, and background UTLs. Screening identified no constituents detected above the groundwater protection SSLs, the tap water RBCs, and/or the background UTLs in either soil or groundwater. Antimony, cyanide and petroleum hydrocarbons were detected in soil, but in the absence of SSLs for these constituents, the soil-to-groundwater, quantitative screening was not performed. This indicates that combined AOC 667 soil is protective of the shallow aquifer.

5.18.2 AOC 667 — Groundwater-to-Surface Water Cross-Media Transport

Groundwater travel time from AOC 667 to the Cooper River is estimated to be 1,353 years. Based on little to no impact to the combined AOC 663 shallow groundwater, the predicted travel time to surface water (not considering the attenuative capacity of the aquifer matrix) and the dilutional capacity of the receiving stream, no significant surface water impacts are expected.

5.18.3 AOC 667 — Soil-to-Air Cross-Media Transport

Table 5.18.2 lists the VOCs detected in surface soil samples collected at AOC 667 and SWMU 138, along with corresponding soil-to-air volatilization screening levels. No VOC's surface soil concentration exceeded its corresponding soil-to-air volatilization screening level. A conservative soil-to-air screening value of 10,000 mg/kg was used for 2-butanone. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.18.1
Chemicals Detected in Soil and Groundwater
Comparison to Groundwater Protection SSLs, Tap Water RBCs and Background UTLs for AOC 667 and SWMU 138
NAVBASE-Charleston, Zone H

Parameter	Media		Ground Water Protection SSL or UTL *	Units	Ground Water Maximum Conc.	Tap Water RBC or UTL *	Units	Exceeds Tap Water RBC or UTL	Exceeds Ground Water Protection SSL or UTL
Acetone	120	780	800	ug/L	ND	370	ug/L	NO	NO
Aluminum	4490	6870	46180	ug/L	ND	3700	ug/L	NO	NO
Antimony	1.4	10.4	NA	ug/L	ND	1.5	ug/L	NO	NO
Arsenic	3.5	10	35.52	ug/L	ND	27.99	ug/L	NO	NO
Barium	8.5	8.7	43.8	ug/L	61.4	323	ug/L	NO	NO
Beryllium	0.15	1.2	180	ug/L	ND	0.016	ug/L	NO	NO
2-Butanone (MEK)	9	ND	570	ug/L	ND	190	ug/L	NO	NO
Cadmium	0.36	0.33	6	ug/L	ND	1.8	ug/L	NO	NO
alpha-Chlordane	3	ND	2000	ug/L	ND	0.052	ug/L	NO	NO
gamma-Chlordane	2	ND	2000	ug/L	ND	0.052	ug/L	NO	NO
Chloroethane	ND	18	3300	ug/L	150	860	ug/L	NO	NO
Chromium	8.6	59.9	85.65	ug/L	ND	18	ug/L	NO	NO
Cobalt	3.4	2.5	14.88	ug/L	ND	220	ug/L	NO	NO
Copper	8.1	8.1	31.62	ug/L	ND	140	ug/L	NO	NO
Cyanide	3.8	ND	NA	ug/L	ND	75	ug/L	NO	NO
4,4'-DDD	5	ND	700	ug/L	ND	0.28	ug/L	NO	NO
4,4'-DDE	3	ND	500	ug/L	ND	0.2	ug/L	NO	NO
1,1-Dichloroethane	10	74	1100	ug/L	17	81	ug/L	NO	NO
Dioxin (TCDD TEQ)	1.0377	ND	280	pg/L	ND	0.5	pg/L	NO	NO
bis(2-Ethylhexyl)phthalate	460	ND	11000	ug/L	ND	4.8	ug/L	NO	NO
Fluorene	720	720	16000	ug/L	ND	150	ug/L	NO	NO
Lead	11.9	14.4	118	ug/L	ND	15	ug/L	NO	NO
Manganese	152	123	1412	ug/L	155	3391	ug/L	NO	NO
Mercury	0.03	ND	3	ug/L	ND	1.1	ug/L	NO	NO
2-Methylnaphthalene	9.3	2600	3000	ug/L	ND	150	ug/L	NO	NO
Naphthalene	ND	670	3000	ug/L	ND	150	ug/L	NO	NO
Nickel	ND	25.5	33.38	ug/L	ND	73	ug/L	NO	NO
Phenanthrene	116	1000	98000	ug/L	ND	150	ug/L	NO	NO
Selenium	ND	2.3	3	ug/L	ND	18	ug/L	NO	NO
2,4,5-T	8.5	ND	260	ug/L	ND	37	ug/L	NO	NO
2,4,5-TP (Silvex)	7.9	ND	1580	ug/L	ND	29	ug/L	NO	NO
Total Petroleum Hydrocarbons	1800	ND	NA	ug/L	ND	NA	ug/L	NO	NO
Toluene	6	6	5000	ug/L	ND	75	ug/L	NO	NO
Vanadium	15.5	42.9	131.6	ug/L	5.3	26	ug/L	NO	NO
Zinc	49.1	54.4	4200	ug/L	ND	1100	ug/L	NO	NO

* - See Table 5.2-1
ug/kg or mg/kg - microgram per kilogram or milligram per kilogram
ug/L or pg/L - microgram per liter or picogram per liter
ng/kg - nanogram per kilogram
NA - Not available
ND - Not detected

TABLE 5.18.2
Soil-to-Air Volatilization Screening Analysis for AOC 667 and SWMU 138
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentration Detected in Surface Soil		Soil to Air SSL *	Units	Exceeds SSL
	AOC 667	AOC 138			
Acetone	0.12	0.056	62000	MG/KG	NO
2-Butanone	0.009	ND	10000 +	MG/KG	NO
Carbon disulfide	ND	0.0046	11	MG/KG	NO
1,1-Dichloroethane	0.01	ND	980	MG/KG	NO
Methylene chloride	ND	0.0129	7	MG/KG	NO
Toluene	0.006	0.0131	520	MG/KG	NO
Xylene (total)	ND	0.0024	730	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentration Tables, March 1995.

+ - Screening value presented for 2-butanone was conservatively estimated at 10,000; actual may be higher.

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5.19 Other Impacted Areas

Other impacted areas include G07, G38, and G80. Surface soil and subsurface soil samples were collected from these areas as part of the Zone H RFI.

5.19.1 Other Impacted Areas — Soil-to-Groundwater Cross-Media Transport

Quantitative screening, Table 5.19.1 identified dieldrin, 4,4'-DDD and 4,4'-DDE in soil at concentrations above the groundwater protection SSLs. Dieldrin was detected marginally above the groundwater protection SSL at location G80 surface soil. 4,4'-DDD and 4,4'-DDE were detected above the groundwater protection SSLs at location G38. These findings indicate that soil-to-groundwater migration could affect the shallow aquifer near grid sampling locations G38 and G80.

5.19.2 Other Impacted Areas — Soil-to-Air Cross-Media Transport

No VOCs were detected in surface soil samples at impacted grid sampling locations G07 and G38. Table 5.19.2 lists the VOCs detected in surface soil samples collected at impacted grid location G80 along with corresponding soil-to-air volatilization screening levels. No VOC's maximum surface soil concentration exceeded its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway would not be expected to be significant at the site.

Table 5.19-1
Chemicals Detected in Soil Above the Groundwater Protection SSL
NAVBASE-Charleston, Zone H, Other Impacted Areas

Parameter	G38 Soil Maximum Conc.	G80 Soil Maximum Conc.	Ground Water Protection SSL or UTL *	Soil Units
4,4'-DDD	3600	ND	700	UG/KG
4,4'-DDE	5700	ND	500	UG/KG
Dieldrin	ND	2.6	1	UG/KG

* - See table 5.2-1
ND - Not detected

TABLE 5.19-2
AOC G80 Soil-to-Air Volatilization Screening Analysis
NAVBASE - Charleston Zone H
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL *	Units	Exceeds SSL
Acetone	0.16	62000	MG/KG	NO
Toluene	0.0029	520	MG/KG	NO

* - Soil-to-air RBCs were obtained from USEPA Region III Risk-based Concentration Tables, March 1995.

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6.0 BASELINE RISK ASSESSMENT APPROACH AND METHODOLOGY

6.1 Introduction

A BRA analyzes potential adverse effects on actual or hypothetical human and ecological receptors that could result from exposures to hazardous substances released from a site if no remedial actions are taken to reduce the extent of environmental contamination. Generally, a BRA is divided into two subsections — one in which human health risk is addressed, and a second in which ecological risk is assessed. The Final Focused Field Investigation (FFI), which will be submitted in conjunction with this RFI, summarizes the sampling results and assesses risk for the inhalation exposure pathway for buildings in a portion of Zone H. Data management and analytical methods used to reach the conclusions of this human health risk assessment are discussed below. The following subsections describe general methods, procedures, considerations, toxicological information, and related uncertainties affecting each SWMU-specific or AOC-specific human health risk assessment (HHRA). Sections 6.1.1 through 6.1.8 are intended to provide a general risk assessment framework/outline, and to avoid presentation of redundant information in subsequent site-specific assessments. As a result, the BRAs in Section 6.2 include only the basic mechanistic and evaluative elements applicable to a particular SWMU or AOC.

The following HHRAs were prepared generally in accordance with the guidelines set forth in:

- *Risk Assessment Guidance for Superfund (RAGS), Volume I — Human Health Evaluation Manual, (Part A)*, (USEPA, 1989a). (RAGS Part A)

- *RAGS, Volume I — Human Health Evaluation Manual, (Part B, Development of Risk-Based Preliminary Remediation Goals)*, (USEPA, 1991a) (RAGS Part B)

- *Dermal Exposure Assessment: Principles and Applications - Interim Report* (USEPA, 1992s).

- Supplemental Guidance to RAGS: Region IV Bulletin, *Human Health Risk Assessment-Interim* (USEPA Region IV , 1995a).

- Supplemental Guidance to RAGS: Region IV Bulletin, *Development of Health-Based Preliminary Remediation Goals, Remedial Goal Options (RGO) and Remediation Levels* (USEPA Region III, 1995). (Supplemental RGO Guidance)

- Supplemental Guidance to RAGS: Region IV Bulletin, *Provisional Guidance of Quantitative Risk Assessment of PAHs* (USEPA Region IV, 1993). (PAH Guidance)

- *Exposure Factors Handbook* (USEPA, 1989d).

- USEPA Region III *Risk-Based Concentration Table, January-June 1995* (USEPA Region III, 1995). (RBC Screening Tables)

- *Technical Memorandum Guidance on Estimating Exposure to VOCs During Showering* (USEPA, 1991c.)

6.1.1 Objectives

The objectives of the BRA are to:

- Characterize the source media and determine the chemicals of potential concern (COPCs) for impacted environmental media.

- Identify potential receptors and quantify potential exposures for those receptors under current and future conditions for all impacted environmental media.

- Qualitatively and quantitatively evaluate the adverse effects associated with the site-specific COPCs in each medium.

- Characterize the potential baseline carcinogenic and noncarcinogenic risks associated with exposure to impacted environmental media at NAVBASE Charleston Zone H under current and future conditions.

- Evaluate the uncertainties related to exposure predictions, toxicological data, and resultant carcinogenic risk and noncarcinogenic hazard predictions.

- Establish for COCs in each environmental medium based on risk/hazard to facilitate risk management decision-making.

The risk assessment will serve a basis for making remedial decisions by identifying detected concentrations potentially causing toxic effects or increased cancer incidences. Variables considered in characterizing the study area are the amount, type, and location of contaminant sources. Variables considered for risk characterization are the pathways of exposure (media type and migration routes); the type, sensitivities, exposure duration, and dynamics of the exposed populations (receptors): and the toxicological properties of identified contaminants.

The focus of each SWMU and/or AOC investigation is detailed in the Site Background and Investigative Approach section for each site. Comprehensive tables show the sample identification numbers and analytical methods applied for each sample. The FFI was conducted in Zone H in 1994 to address possible soil-to-air pathway concerns in buildings near SWMU 9. Where the FFI overlapped areas investigated during the Zone H RFI, potential air pathway concerns are discussed in the appropriate site-specific human health risk assessments. At most SWMUs and AOCs, sampling activities consisted of the collection of surface (0- to 1-foot interval) and subsurface (generally 4- to 5-foot interval) soil samples, as well as groundwater samples from monitoring wells installed in the shallow and deep aquifers underlying the zone. Analytical results from surface soil, shallow groundwater, and deep groundwater were used to assess possible exposure to environmental contaminants.

Organization

A human health risk assessment, as defined by RAGS Part A, includes the following steps:

- *Site characterization:* Evaluation of data regarding site geography, geology, hydrogeology, climate, and demographics.

- *Data collection:* Analysis of environmental media samples, including background/ reference samples.

- *Data evaluation:* Statistical analysis of analytical data to identify the nature and extent of contamination and to establish a preliminary list of COPCs based on risk-based and background screening. This list will subsequently be refined to identify COCs.

- *Exposure assessment:* Identification of potential receptors under current and predicted future conditions and potential exposure pathways, and calculation/quantitation of exposure point concentrations (EPCs) and chemical intakes.

- *Toxicity assessment:* Qualitative evaluation of the adverse effects of the COPCs, and quantitative estimate of the relationship between exposure and severity or probability of effect.

- *Risk characterization:* Combination of the outputs of the exposure assessment and the toxicity assessment to quantify the total noncancer and cancer risk to the hypothetical receptors.

Because duplicate samples were collected for QA/QC, some sample locations had more than one analytical result. One objective of data management was to provide one result per sample location per analyte. The mean of duplicate sample results was used as the applicable value, unless the analyte was detected in only one duplicate sample. In such cases, the detection results were used.

In addition, limitations of analytical results were addressed in the human health risk assessments by including estimated concentration values for nondetected parameters. A nondetect indicates that the analyte was not detected above the quantitation limit of the sample (U-qualified results), which is determined by the analytical method, the instrument used, and possible matrix interferences. However, a nondetected analyte could be present at a concentration at any level between zero and the quantitation limit. For this reason, one-half the U-value could serve as an unbiased estimate of the nondetect. Because the estimated values of J-qualified hits were frequently much lower than the sample quantitation limits of U-qualified nondetects for organic compounds, one-half of each U-value was compared to one-half of the lowest hit (normally J-qualified) at the same site. The lesser of these two values was used as the best estimate of the concentration that was potentially present below the sample quantitation limit, and was inserted into the adjusted dataset. For inorganic chemicals, the decision rule was simpler: one-half of each U-value was used to represent the concentration of the corresponding sample when compiling the adjusted dataset. If two nondetects were reported for any one location (a result of QA/QC samples), one-half the lesser of the U-values was compared to the lowest hit at the site (for organics, as above) or applied directly (for inorganics) to estimate a concentration value to be used in the Zone H RFI risk calculations. If a parameter was not detected at a SWMU/AOC, neither data management method was applied, and the parameter was not considered in screening or formal assessment.

After the dataset was complete (i.e., after elimination of faulty data, consolidation of duplicate data values, and quantification of censored values), statistical methods were used to evaluate the

RFI analytical results to identify COPCs and establish EPCs at potential receptor locations. The statistical methods used in data evaluation are discussed below. The rationale used to develop this method and the statistical techniques to implement it are based on the following sources:

- RAGS Part A
- *Statistical Methods for Environmental Pollution Monitoring* (Gilbert, 1987)
- Supplemental Guidance to RAGS: Calculating the Concentration Term, (USEPA, 1992c)

Microsoft FoxPro[1] and Borland Quattro Pro[1] were used for data management and statistical calculations. For each dataset used to describe the concentration of chemicals in a contaminated area, the following was tabulated: frequency of detection, range of detected values, average of detected concentrations, and the calculated 95th percentile upper confidence limit (UCL) on the mean of log-transformed values of the concentration. In accordance with RAGS, the lesser of either the maximum concentration detected or the UCL was used to quantify potential exposure. This procedure is detailed in Exposure Assessment Section 6.1.3.

6.1.2.4 Selection of Chemicals of Potential Concern

The objective of this section was to screen the available information on the CPSSs detected at each SWMU or AOC to develop a list or group of COPCs. These chemicals are selected by comparison with screening concentrations (risk-based and reference), intrinsic toxicological properties, persistence, fate and transport characteristics, and cross-media transport potential. For any COPC to be considered a COC, and warrant assessment relative to corrective measures, it must meet two criteria. First, the COPC must contribute to an exposure pathway with an incremental lifetime excess cancer risk (ILCR) in excess of 1E-6 or hazard index (HI) greater than 1 for any of the exposure scenarios evaluated in the risk assessment. Secondly, the COPC

[1] References to specific software products are not to be construed as an endorsement by the U.S. Navy or E/A&H.

must have an individual risk projection greater than 1E-6 or hazard quotient (HQ) greater than 0.1. ILCR, HQ, and HI are detailed in Toxicity Assessment and Risk Characterization, Sections 6.1.4 and 6.1.5 of this report.

Before evaluating the potential risks/hazards associated with site media, it is necessary to delineate the site contamination which was accomplished by noting the chemicals detected in environmental media. These chemicals represent the CPSSs for each SWMU or AOC. Because human health risk and hazard will ultimately direct remedial action, detailed discussions of COC extent were deferred to site-specific HHRAs. The risk characterization section of each human health risk assessment provides risk and hazard maps for COCs (where data support such depictions) to provide visual aids in interpreting the risk assessment outputs. Where data do not support development of mass impacted locations are discussed by medium. To reduce the list of CPSSs and focus the risk assessment on COPCs, two comparisons were performed as described below.

6.1.2.4.1 Comparison of Site-Related Data to Risk-Based Screening Concentrations

The maximum concentrations of CPSSs detected in samples were compared to risk-based screening values in *Determination of COCs by Risk-Based Screening*, USEPA Region III, March 18, 1994, and subsequent versions. USEPA used a target an HQ of 0.1 and a risk goal of 1E-6 to calculate screening concentrations for noncarcinogens and carcinogens. When use of more recent of USEPA Region III's RBC tables was necessary, noncarcinogenic chemical values were adjusted to equate with an HQ of 0.1.

Groundwater (and surface water, where applicable) results were compared to tap water screening values, and reported soil (and sediment, where applicable) concentrations were compared to residential soil ingestion screening values. The soil screening value for lead was set equal to 400 mg/kg, consistent with recent OSWER directives considering protection of a hypothetical child resident; the lead groundwater screening value used was the USEPA Office of Water treatment technique action level of 15 μg/L.

A soil screening value of 1 μg/kg (as 2378-TCDD equivalents or total TEQs) was applied to chlorinated dibenzodioxins and dibenzofurans. This concentration is based on a worker/industrial scenario and a risk level of 1E-04. USEPA Region IV has determined this to be an appropriate cleanup level although normally 1E-06 is used as the cleanup level trigger. For dioxin, USEPA Region IV sees this as a prudent course in light of the high level of uncertainty associated with dioxin exposure concentrations at which adverse effects occur. The Koppers site, located in Charleston, South Carolina, presented a similar dioxin cleanup concentration of 2.5 μg/kg in a pending Record of Decision. For groundwater, the TEQ value computed for each sample was compared to the 2,3,7,8-TCDD tap water screening level.

In accordance with recent carcinogenic polynuclear aromatic hydrocarbons (cPAH) guidance, benzo(a)pyrene-equivalent (BEQ) concentrations were computed, where appropriate, by multiplying the reported concentration of each cPAH by its corresponding toxicity equivalency factor (TEF). The BEQ values were then summed for each sample, and the total was compared to the benzo(a)pyrene RBC value during the screening process. Subsequent exposure quantification and risk/hazard projections for cPAHs in soil and groundwater were performed using total BEQ values for each sampling location rather than individual compound concentrations.

CPSSs with maximum detected concentrations exceeding their corresponding concentrations, goals, and/or standards were retained for further evaluation and reference screening in the risk assessment. Screening values based on surrogate compounds were used if no screening values were available in USEPA's table. Surrogate compounds were selected based on structural, chemical, or toxicological similarities.

The relevance of groundwater RBC screening is discussed in Sections 6.1.3 and 6.1.6. Because shallow and deep groundwater beneath most areas of Zone H contains chlorides and/or total dissolved solids (TDS) above South Carolina potable source criteria, water from these aquifers is not appropriate for domestic use. Consequently, screening the concentrations of compounds detected in groundwater against tap water RBCs provides a highly conservative assessment of the significance of groundwater impacts.

For CPSSs found in both soil (all depths) and shallow groundwater, an additional risk-based screening process was performed as part of the fate and transport assessment. Maximum soil concentrations were compared to the soil-to-groundwater cross-media protection values provided in the RBC Table, January to June 1995, USEPA Region III.

6.1.2.4.2 Comparison of Site-Related Data to Background Concentrations

Soil and groundwater background (or reference) concentrations were determined across Zone H, using results from the grid-based soil and groundwater background sampling locations. Surface soil, subsurface soil, and shallow and deep groundwater were all addressed separately in Appendix J, the background evaluation. Statistical methods and rationale for determining of background concentrations and comparison of site data to background were proposed in the May 12, 1995, technical memorandum *Proposed Method for Comparing Site Sample Values to Background Values for Surface and Subsurface Soil I: Inorganics* (E/A&H, 1995a), which has been incorporated into Appendix J. This technical approach was approved for use in Zone H by USEPA Region IV and SCDHEC. Following comparison to risk- and hazard-based screening values, COPCs were retained for further consideration as COCs in the human health risk assessment on a SWMU-or AOC-specific basis if their maximum detected concentrations exceeded corresponding background reference concentrations, or their overall site concentrations were significantly greater than corresponding overall background concentrations as determined by Wilcoxon rank sum test procedures. The two statistical background comparisons were conducted as parallel analyses. If either method suggested that site-specific concentrations deviated from naturally occurring levels, the chemical was retained for formal risk assessment. These comparisons assist in accounting for chemicals that are common in nature such as aluminum, manganese, and arsenic. By virtue of this process, risk and/or hazard associated with naturally occurring chemicals is not addressed where their concentrations are not above corresponding background. For purposes of this RFI report, reference concentration is synonymous with background concentration as defined above.

The background reference concentration UTL is a fixed value determined to represent the upper bound of naturally occurring levels for a chemical in a specific matrix. Comparisons using reference concentrations are most effective in identifying "hot spots," limited areas with pronounced impacts. Population tests, in this case performed using the Wilcoxon rank sum method, are used to determine whether values from one population (the site samples) are consistently higher or lower than those from another (the entire background dataset). Ideally, population tests identify general elevations in chemical concentrations absent definable hot spots. Statistical methods, UTL calculations, Wilcoxon rank sum test outputs and general background sample information are in Appendix J.

In the RFI, if the maximum concentration of a CPSS was less than either background or the risk-based screening value, it was not considered further in the risk assessments unless deemed appropriate based on chemical-specific characteristics (e.g., degradation product with greater toxicity).

6.1.2.4.3 Elimination of Essential Elements: Calcium, Iron, Magnesium, Potassium, and Sodium

In accordance with RAGS Part A, essential elements that are potentially toxic only at extremely high concentrations may be eliminated from further consideration as COPCs in a risk assessment. Specifically, an essential nutrient may be screened out of a risk assessment if it is shown to be present at concentrations that are not associated with adverse health effects. Based on RAGS, the lack of risk-related data, and USEPA Region IV's recommendations, the following essential nutrients were eliminated from the HHRA: calcium, iron, magnesium, potassium, and sodium.

6.1.2.4.4 Summary of COPCs

The results of the screening evaluations are presented on a medium-specific basis in each HHRA.

In summary, the risk information usually obtained from the Integrated Risk Information System (IRIS) or Health Effects Assessment Summary Tables (HEAST) is necessary to calculate risk and hazard estimates (and risk-based screening values). This information is based on toxicological and epidemiological data which are critiqued and approved by the scientific and regulatory community (i.e., listed in IRIS and/or HEAST). Risk information was not available for some CPSSs; therefore, it was not possible to calculate risk and/or hazard for those chemicals. For each environmental medium sampled at a SWMU or AOC, the data were screened using risk-based and background values. The results of the screening process are presented in tables in each specific human health risk assessment. Those chemicals determined to be COPCs through the screening process are designated with an asterisk. Total isomer concentrations reported for chlorinated dibenzodioxins and dibenzofurans (e.g., "Total HxCDD") were not specifically used in formal assessment per USEPA protocol. Instead, exposure was estimated for each individually quantitated congener (e.g., "123478-HxCDD"). No risk-based screening values are available for the generic group TPH. As a result, TPH was assessed based on state UST regulations and the NAVBASE soil action level of 100 mg/kg. If no groundwater impacts were identified, the soil concentrations were considered sufficiently protective of the underlying aquifer.

6.1.2.5 Calculation of Risk and Hazard

As previously discussed, CPSSs that exceed their respective screening values are considered COPCs. COCs are subsequently identified in a two-phase process. First, exposure pathways that exceed the screening criteria established by USEPA and SCDHEC are identified. Identifying COCs from the refined list of COPCs involves calculating chemical-specific cancer risks and HQs for COPCs, estimating exposure-pathway risk/hazard, evaluating frequency and consistency of detection and relative chemical toxicity, and comparison to background concentrations. In the next step, those COPCs which individually exceed 1E-6 ILCR or a HQ greater than 0.1 in a pathway of concern (i.e., an exposure pathway having ILCR greater than 1E-6 or HI greater than 1) are retained as COCs. Section 6.1.4, Toxicity Assessment, discusses cancer risk thresholds and noncancer toxicity in detail.

6.1.3 Exposure Assessment

This section of the HHRA determines the magnitude of contact that a potential receptor may have with site-related COPCs. Where applicable, the FFI is referenced for air pathway-related exposure assessment discussions. Exposure assessment involves four stages:

- Characterizing the physical setting and land use of the site

- Identifying COPC release and migration pathway(s)

- Identifying the potential receptors, under various land use or site condition scenarios, and the pathways through which they might be exposed

- Quantifying the intake rates, or contact rates, of COPCs.

6.1.3.1 Exposure Setting and Land Use

This section of each HHRA describes the basic layout of the SWMU or AOC as well as the suspected source(s) of contamination. Where multiple SWMUs and AOCs were combined for the RFI, the rationale for grouping is discussed. In addition, the site's projected future use is discussed if information was available. Present land use in Zone H is comparable to civilian industrial, commercial, and office uses. Current base reuse plans call for continued industrial and office settings, with small portions of the property set aside as recreation areas.

At some SWMUs/AOCs, site features such as asphalt surfaces, buildings, and fences would preclude or minimize exposure to impacted media if they were maintained under base reuse plans. As part of each site-specific human health risk assessment, the potential influences of site features on exposure was evaluated. Where current site features affect how an individual might be exposed, detailed analyses were performed to calculate alternate EPCs and to derive factors to account for fraction ingested/contacted from the contaminated source. The assessments performed in consideration of existing features are presented as an additional exposure scenario within the quantification of exposure and risk characterization sections of the site-specific HHRA.

6.1.3.2 Potentially Exposed Populations

In each site-specific HHRA, this section describes who may be exposed to contaminants in environmental media, currently or in the future. For purposes of the Zone H HHRA, the potentially exposed populations addressed were current and future site workers, as well as hypothetical future site residents. Because current site workers at most sites within Zone H would be expected to have limited contact with contaminated media, worker-related exposure was addressed exclusively for maximally exposed future site workers. This approach, while providing a reasonably conservative assessment of future site worker risk/hazard, also renders a highly conservative approximation of risk/hazard for current site workers. It also accounts for the fact that the specific nature of future industrial users cannot be definitively stated.

6.1.3.3 Exposure Pathways

This section of each HHRA briefly summarizes how potential receptors (site workers, residents, etc.) may be exposed to contaminated media. In general, soil matrix-related pathways include incidental ingestion and dermal contact. For groundwater, ingestion and inhalation of volatilized contaminants were the primary exposure pathways evaluated. For RFI sites (buildings) within the scope of the Zone H FFI, the air inhalation pathway is addressed for current site workers and potential future building occupants. Soil-to-groundwater and soil-to-air cross-media protection factors are also discussed where appropriate.

6.1.3.4 Exposure Point Concentrations

The EPC is the concentration of a contaminant in an exposure medium that will be contacted by a real or hypothetical receptor. Determining the EPC depends on factors such as:

- Availability of data
- Amount of data available to perform statistical analysis
- Reference concentrations not attributed to site impacts
- Location of the potential receptor

USEPA Region IV guidance calls for assuming lognormal distributions for environmental data and the calculation of the 95th percentile UCL on the mean for use in exposure quantification. Applying the UCL is generally inappropriate when the number of samples is less than 10. The maximum concentrations detected were used for all datasets with less than 10 samples. In general, outliers have been included when calculating the UCL because high values seldom appear as outliers for a lognormal distribution. Including outliers increases the overall uncertainty of the calculated risks and conservatively increases the estimate of the human health threat.

For sample sets of 10 and greater, the UCL was calculated for a lognormal distribution as follows:

$$UCL = e^{\left(\bar{a}+0.5s_a^2 + \frac{H_{0.95}\ x\ s_a}{\sqrt{n-1}}\right)}$$

where:

$\bar{a}$ = $\Sigma a/n$ = sample arithmetic mean of the log-transformed data, a = ln(x)

s_a = sample standard deviation of the log-transformed data

n = number of samples in the dataset

$H_{0.95}$ = value for computing the one-sided 95% confidence limit on a lognormal mean from standard statistical tables (Gilbert, 1987)

The calculated values for the 95% UCL are presented in tables which summarize COPCs identified in each environmental medium. Included for each COPC are the number of samples analyzed, mean and standard deviation of the natural log-transformed data (including the nondetect values), the H-statistic, the maximum of detected concentrations, and background concentrations (where available). For media from which less than 10 samples were collected, the maximum of positive detections of each COPC identified was used as the EPC to compute exposure.

As described in Section 6.1.3.1, considering current features or skewed contaminant distributions in quantifying exposure potential required the calculation of modified or alternate EPCs for some SWMUs/AOCs. The modified EPCs were derived to account for the fraction of impacted areas currently covered with asphalt surface, buildings, etc.; if these features are maintained, they would preclude direct exposure to affected areas (surface soil). In some instances, factors were derived to modify the EPC to account for the fraction ingested/contacted from the contaminated source. This approach was used where impacts were found to be extremely limited in areal extent (hot spots). Where this approach was taken, the basis for the decision was discussed in the site-specific HHRA.

As previously discussed in Section 6.1.2.3 of this document, analytical results are presented as "nondetects" whenever chemical concentrations in samples do not exceed the detection or quantitation limits for the analytical procedures as applied to each sample. Generally, the quantitation limit is the lowest concentration of a chemical that can be reliably quantified above the normal, random noise of an analytical instrument or method. To apply the above-mentioned statistical procedures to a dataset with reported nondetects for organic compounds, the lesser of one-half of the nondetect value for the sample or the lowest J-qualified value at the site was assumed to be the applicable default concentration. For inorganic chemicals, one-half of the nondetect value was assumed to be the applicable concentration. Using this method is a reasonable compromise between use of zero and using the sample quantitation limit to reduce the bias (positive or negative) in the calculated UCL.

6.1.3.5 Quantification of Exposure

This section describes the models, equations, and input parameter values used to quantify doses or intakes of the COPCs for the surface soil and groundwater exposure pathways. The models are designed to estimate route- and medium-specific factors, which are multiplied by the EPC to estimate chronic daily doses. The intake model variables generally reflect 50th or 95th percentile values which, when applied to the EPC, ensure that the estimated intakes represent the reasonable maximum exposure (RME). Formulae were derived from RAGS, Part A unless otherwise indicated. Table 6.1.1, at the end of Section 6.1, lists input parameters used to compute chronic daily intake (CDI) for potential receptors exposed to surface soil and/or groundwater contaminants. These soil and groundwater pathway assumptions were applied for each SWMU and AOC in Zone H. In instances where other exposure routes/pathways were identified (or predicted), additional exposure quantification formulae are presented. Because Zone H is part of BRAC III, future site use cannot be determined with any certainty. Therefore, conservative assumptions were used to account for any reasonable future use. Zone H media analytical results and exposure methods have been formatted to allow for fine-tuning of exposure estimates based on actual conditions as base reuse plans materialize.

Age-adjusted ingestion factors were derived for the potential future residential receptors (resident adult and resident child combined) for carcinogenic endpoints. These factors consider the difference in daily ingestion rates for soil and drinking water, body weights, and exposure durations for children (ages 1 to 6 years) and adults (ages 7 to 31 years). The exposure frequency is assumed to be identical for the adult and child exposure groups.

6.1.3.5.1 Surface Soil Pathway Exposure

Ingestion of COPCs in Surface Soil

The following equation is used to estimate the ingestion of COPCs in soil:

$$CDI_s = (C_s)(IR)(EF)(ED)(F)(FI)/(BW)(AT)$$

where:

CDI_s	=	ingested dose (mg/kg-day)
C_s	=	concentration of contaminant in soil (mg/kg)
IR	=	ingestion rate (mg/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
F	=	conversion factor (1E-6 kg/mg)
FI	=	fraction ingested from contaminated source (unitless)
BW	=	body weight (kg)
AT	=	averaging time (days)

Dermal Contact with COPCs in Surface Soil

The following equation is used to estimate intake due to dermal contact with COPCs in soil:

$$CDI_{sd}=(C_s)(CF)(EF)(ED)(F)(FC)(ABS)(AF)/(BW)(AT)$$

where:

CDI_{sd}	=	dermal dose (mg/kg-day)
C_s	=	concentration of contaminant in soil (mg/kg)
CF	=	contact factor (cm^2)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
F	=	conversion factor (1E-6 kg/mg)
FC	=	fraction contacted from contaminated source (unitless)
ABS	=	absorption factor (unitless value, specific to organic versus inorganic compounds)
AF	=	adherence factor (mg/cm^2)
BW	=	body weight (kg)
AT	=	averaging time (days)

6.1.3.5.2 Groundwater Pathway Exposure

Ingestion and Inhalation of COPCs in Groundwater

The following equation is used to estimate the ingestion and/or inhalation of COPCs in groundwater:

$$CDI_w=(C_w)(IR)(EF)(ED)(FI)/(BW)(AT)$$

where:

CDI_w = ingested/inhaled dose (mg/kg-day)

C_w = concentration of contaminant in water (mg/l)

IR = ingestion rate (l/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

FI = fraction ingested from contaminated source (unitless)

BW = body weight (kg)

AT = averaging time (days)

Figures 6.1.1 and 6.1.2 provide the formulae for calculating the CDI for soil and groundwater. Tables are provided in the HHRA for each SWMU or AOC presenting the quantification of exposure to environmental media through all applicable pathways. Future site worker and hypothetical site resident exposure are projected separately. In accordance with USEPA guidance, the potential exposure to volatiles originating from groundwater during domestic uses such as showering has been estimated to be equivalent to the ingestion of 2 liters/day of contaminated groundwater. To provide a conservative assessment of industrial exposure to groundwater, it was assumed that workers would shower at work using site groundwater. Although the inhalation CDI computed on this basis is equal to that for ingestion exposures, risk and/or hazard associated with inhaled volatile contaminants are characterized using toxicological values specific to the inhalation pathway (e.g., inhalation slope factors and reference doses).

6.1.4 Toxicity Assessment

6.1.4.1 Carcinogenicity and Noncancer Effects

The USEPA has established a classification system for rating the potential carcinogenicity of environmental contaminants based on the weight of scientific evidence. The cancer classes are described below. Cancer weight-of-evidence class "A" (human carcinogens) means that human toxicological data have shown a proven correlation between exposure and the onset of cancer (in varying forms). The "B1" classification indicates some human exposure studies have implicated the compound as a probable carcinogen. Weight-of-evidence class "B2" indicates a possible human carcinogen, a description based on positive laboratory animal data (for carcinogenicity) in the absence of human data. Weight-of-evidence class "C" identifies possible human carcinogens, and class "D" indicates a compound not classifiable with respect to its carcinogenic potential. The USEPA has established slope factors (SFs) for carcinogenic compounds. The SF is defined as a "... plausible upper-bound estimate of the probability of a response (cancer) per unit intake of a chemical over a lifetime ..."(RAGS, Part A).

In addition to potential carcinogenic effects, most substances can also produce other toxic responses at doses greater than experimentally derived threshold concentrations. The USEPA has derived Reference Dose (RfD) values for these substances. A chronic RfD is defined as "... an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure concentration for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime." These toxicological values are used in risk formulae to assess the upper-bound level of cancer risk and noncancer hazard associated with exposure to a given concentration of contamination.

Figure 6.1.1

Formulae for Calculating CDI for Soil

SOIL INGESTION PATHWAY

Residential Scenario:

Noncarcinogens - Child - Residential Scenario:

$$CDI_{NC\text{-}C} = \frac{C_s \times IR_{soil/child} \times EF_{res} \times F \times FI \times ED_{child}}{AT_{NC\text{-}C} \times BW_{child}}$$

Noncarcinogens - Adult - Residential Scenario:

$$CDI_{NC\text{-}A} = \frac{C_s \times IR_{soil/adult} \times EF_{res} \times F \times FI \times ED_{adult}}{AT_{NC\text{-}A} \times BW_{adult}}$$

Carcinogens (based on a lifetime weighted average):

$$CDI_C = \frac{C_s}{AT_C} \left[\frac{IR_{soil/child} \times EF_{res} \times F \times FI \times ED_{child}}{BW_{child}} + \frac{IR_{soil/adult} \times EF_{res} \times F \times FI \times ED_{adult}}{BW_{adult}} \right]$$

Figure 6.1.1 (continued)

Formulae for Calculating CDI for Surface Soil

SOIL DERMAL CONTACT PATHWAY

Residential Scenario:

Noncarcinogens - Child - Residential Scenario:

$$CDI_{NC\text{-}C} = \frac{C_s \times CF_{soil/child} \times EF_{res} \times F \times FC \times AF \times ABS \times ADJ \times ED_{child}}{AT_{NC\text{-}C} \times BW_{child}}$$

Noncarcinogens - Adult - Residential Scenario:

$$CDI_{NC\text{-}A} = \frac{C_s \times CF_{soil/adult} \times EF_{res} \times F \times FC \times AF \times ABS \times ADJ \times ED_{adult}}{AT_{NC\text{-}A} \times BW_{adult}}$$

Carcinogens (based on a lifetime weighted average):

$$CDI_C = \frac{C_s}{AT_C} \times \left[\frac{CF_{soil/child} \times EF_{res} \times F \times FC \times AF \times ABS \times ADJ \times ED_{child}}{BW_{child}} + \frac{CF_{soil/adult} \times EF_{res} \times F \times FC \times AF \times ABS \times ADJ \times ED_{adult}}{BW_{adult}} \right]$$

- *Uncertainty:* Discussion and evaluation of the areas of recognized uncertainty in human health risk assessments in addition to medium- and exposure pathway-specific influences.

- *Risk/Hazard Summary:* Presentation and discussion of the results of the quantification of exposure (risk and hazard) for the potential receptors and their exposure pathways identified under the current and future conditions.

- *Remedial Goal Options:* Computation of exposure concentrations corresponding to risk projections within the USEPA target risk range of 1E-6 to 1E-4 for carcinogenic COCs and hazard quotient goals of 0.1, 1, and 3 for noncarcinogenic COCs.

This general process was followed in preparing the BRA for each SWMU and AOC within Zone H at NAVBASE Charleston.

6.1.2 Site Characterization

When performing an HHRA, data are compiled to determine potential site-related chemicals and exposures for each medium as outlined in RAGS Part A. The steps for identifying COPCs are discussed below.

6.1.2.1 Data Sources

As part of each investigation, soil, groundwater, surface water, sediment, air, and other samples were collected and analyzed to delineate the sources, nature, magnitude, and extent of any contamination associated with current or past site operations. The data used in the BRA for each SWMU or AOC were obtained from the results of the RFI and associated sampling activities.

6.1.2.2 Data Validation

Data validation is an after-the-fact, independent, systematic process of evaluating data and comparing them to established criteria to confirm that they are of the technical quality necessary to support the decisions made in the RFI process. Parameters specific to the data are reviewed to determine whether they meet the stipulated DQOs. The quality objectives address five principal parameters: precision, accuracy, completeness, comparability, and representativeness. To verify that these objectives are met, the following are examined to determine compliance with appropriate and applicable procedures: field measurements, sampling and handling procedures, laboratory analysis and reporting, and nonconformances and discrepancies in the data.

Zone H data were validated in accordance with the USEPA Contract Laboratory Program (CLP) Organic and Inorganic Functional Guidelines (USEPA, 1994a/b), as detailed in Appendix K of this RFI report. In their validated form, the Zone H data were deemed usable for risk assessment purposes. Chlorinated dibenzodioxin and dibenzofuran data were closely scrutinized due to the analytical laboratory's departure from standard analytical methods. Although each SDG was not affected in the same way, some chlorinated dibenzodioxin and dibenzofuran data were qualified as EMPC during data validation. The technical rationale for imposing the EMPC qualifier is detailed in Appendix K. Projected human health or ecological risk estimates based on these EMPC-qualified results probably represent the absolute maximum potential exposure and should be considered highly conservative.

6.1.2.3 Management of Site-Related Data

All environmental sampling data were evaluated for suitability for use in the quantitative BRA. Data obtained in the following ways were not considered appropriate for the quantitative BRA:

- Analytical methods that are not specific for a particular chemical, such as total organic carbon or total organic halogen.

- Field screening instruments including total organic vapor monitoring units and organic vapor analyzers.

Figure 6.1.1 (continued)

Formulae for Calculating CDI for Surface Soil

Variable	Description
BW_{child}	average child body weight (ages 1-6) (kg)
BW_{adult}	average adult body weight (kg)
ABS	absorbance factor (unitless value specific to organic versus inorganic compounds)
ADJ	dermal to absorbed dose adjustment factor (unitless value specific to VOCs, SVOCs, and inorganic compounds)
AF	adherence factor (1 mg/cm^2)
ED_{child}	child exposure duration during (ages 1-6) (yr)
ED_{adult}	adult exposure duration during (ages 7-31) (yr)
$ED_{adult-w}$	adult worker exposure duration during (yr)
EF_{res}	residential exposure frequency (days/year)
EF_{w}	worker exposure frequency (days/year)
$IR_{soil/child}$	child soil intake rate (mg/day)
$IR_{soil/adult}$	adult soil intake rate (mg/day)
FC	fraction contacted from contaminated source (unitless = 1)
$CF_{soil/child}$	child soil dermal contact factor (mg/day)
$CF_{soil/adult}$	adult soil dermal contact factor (mg/day)
AT_{C}	averaging time (carcinogen)
AT_{NC-A}	averaging time (noncarcinogen adult)
AT_{NC-C}	averaging time (noncarcinogen child)
C_{s}	chemical concentration in surface soil (mg/kg)
FI	fraction ingested from contaminated source (unitless = 1)
F	conversion factor (1E-6 kg/mg)

Notes:

— CDI indicates Chronic Daily Intake

— The worker scenario risk and hazard were calculated by substituting worker-specific assumptions into the adult portions of the formulae and then deleting the child portions of the formulae.

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Figure 6.1.2

Formulae for Calculating CDI for Groundwater

GROUNDWATER INGESTION PATHWAY

Residential Scenario:

Noncarcinogens - Child - Residential Scenario:

$$CDI_{NC\text{-}C} = \frac{C_w \times IR_{water/child} \times EF_{res} \times ED_{child} \times FI}{AT_{NC\text{-}C} \times BW_{child}}$$

Noncarcinogens - Adult - Residential Scenario:

$$CDI_{NC\text{-}A} = \frac{C_w \times IR_{water/adult} \times EF_{res} \times ED_{adult} \times FI}{AT_{NC\text{-}A} \times BW_{adult}}$$

Carcinogens (based on a lifetime weighted average):

$$CDI_C = \frac{C_w}{AT_C} \left[\frac{IR_{water/child} \times EF_{res} \times ED_{child} \times FI}{BW_{child}} + \frac{IR_{water/adult} \times EF_{res} \times ED_{adult} \times FI}{BW_{adult}} \right]$$

Figure 6.1.2 (continued)

Formulae for Calculating CDI for Groundwater

PATHWAY: GROUNDWATER INHALATION WHILE SHOWERING

Residential Scenario:

In accordance with *Technical Memorandum Guidance on Estimating Exposure to VOCs During Showering* (USEPA, 1991c):

$$CDI_{ingestion} = CDI_{inhalation}$$

Variable	Description
BW_{child}	average child body weight (ages 1-6) (kg)
BW_{adult}	average adult body weight (kg)
ED_{child}	child exposure duration during (ages 1-6) (yr)
ED_{adult}	adult exposure duration during (ages 7-31) (yr)
$ED_{adult-w}$	adult worker exposure duration during (yr)
EF_{res}	residential exposure frequency (days/year)
EF_{w}	worker exposure frequency (days/year)
$IR_{water/child}$	child water intake rate (mg/day)
$IR_{water/adult}$	adult water intake rate (mg/day)
FI	fraction ingested from contaminated source (unitless = 1)
AT_{C}	averaging time (carcinogen)
AT_{NC-A}	averaging time (noncarcinogen adult)
AT_{NC-C}	averaging time (noncarcinogen child)
C_{w}	chemical concentration in groundwater (mg/l)

Notes:

- CDI indicates Chronic Daily Intake
- The worker scenario risk and hazard were calculated by substituting worker-specific assumptions into the adult portions of the formulae and then deleting the child portions of the formulae.

For carcinogens, the potential risk posed by a chemical is computed by multiplying the CDI (as mg/kg-day) by the SF (in reciprocal mg/kg-day). The HQ (for noncarcinogens) is computed by dividing the CDI by the RfD. The USEPA has set standard limits (or points of departure) for carcinogens and noncarcinogens to evaluate whether significant risk is posed by a chemical (or combination of chemicals). For carcinogens, the point-of-departure range is 1E-6, with a generally accepted range of 1E-6 to 1E-4. These risk values correlate with 1 in 10,000 and 1 in 1 million excess incidence of cancer resulting from exposure to xenobiotics (all pathways).

For noncarcinogens, other toxic effects are generally considered possible if the HQ (or sum of HQs for a pathway — hazard index) exceeds unity (a value of 1). Although both cancer risk and noncancer hazard are generally additive (within each group) only if the target organ is common to multiple chemicals, a most conservative estimate of each may be obtained by summing the individual risks or hazards, regardless of target organ. The following HHRA have taken the universal summation approach for each class of toxicant. Details regarding the risk formulae applied to site data are provided in the risk characterization section of this document.

Critical studies used in establishing toxicity classifications by USEPA are shown in the IRIS database (primary source) and/or HEAST, Fiscal Year 1995 (secondary source). If toxicological information is unavailable in IRIS or HEAST, values were obtained from reports issued by Environmental Criteria and Assessment Office (ECAO) Nation Center for Environmental Assessment (NCEA). Where applicable, these values were also included in the database for these HHRA. The HHRA for each site with identified COPCs includes a table summarizing toxicological data in the form of RfDs and SFs obtained for the relevant COPCs, as well as uncertainty/modifying factors, target organs, and cancer classes (where available). If fewer than three COPCs are identified for a specific SWMU or AOC, the above-referenced information may be provided exclusively in narrative form.

6.1.4.2 Toxicity Profiles for COPCs

In accordance with RAGS, the human health risk assessments include brief toxicological profiles for all COPCs. Most information for the brief profiles was gleaned from IRIS and HEAST, as mentioned in the preceding text and toxicological database information table. Any additional references are noted specifically in the profiles. The profiles summarize adverse effects of COPCs and the amount of the COPC associated with adverse effects.

6.1.5 Risk Characterization

Risk characterization combines the results of the exposure assessment and toxicity assessment to yield qualitative and quantitative expressions of risk and/or hazard for the exposed receptors. The quantitative component expresses the probability of developing cancer, or a nonprobabalistic comparison of the estimated dose with a reference dose for noncancer effects. These quantitative estimates are developed for individual chemicals, exposure pathways, transfer media, and source media, and for each receptor for all media to which one may be exposed. The qualitative component usually involves comparing COC concentrations in media with established criteria or standards for chemicals for which there are no corresponding toxicity values. The risk characterization is used to guide risk management decisions.

Generally, the risk characterization follows the methods prescribed by RAGS Part A, as modified by more recent information and supplemental guidance cited in the earlier sections of this report. The USEPA methods are appropriately designed to be health-protective, and tend to overestimate, rather than underestimate, risk. The risk results, therefore, are generally overly conservative, because risk characterization involves multiplying the conservative assumptions built into the exposure and toxicity assessments.

This section of each HHRA characterizes the potential health risks associated with the intake of chemicals originating from the respective site. The USEPA methods used to estimate the types and magnitudes of health effects associated with exposure to chemicals have been supplemented, where appropriate, by graphical representations of risk and hazard. This supplemental information is presented to more clearly depict the problem areas at the relevant sites on scales specific to individual sampling points.

Risk Characterization Methodology

Potential risks to humans following exposure to COPCs are estimated using methods established by USEPA, when available. As discussed above, these methods are health-protective and are likely to overestimate risk. Risks from hazardous chemicals are calculated for either carcinogenic or noncarcinogenic effects. Some carcinogenic chemicals may also pose a noncarcinogenic hazard. The potential human health effects associated with chemicals that produce systemic toxic and carcinogenic influences are characterized for both types of health effects. As mentioned in Section 6.1.3, inhalation exposure-related risk and hazard were computed using appropriate route-specific (inhalation) SFs and RfDs (where available).

Unlike the methods for estimating inhaled or ingested dose of COPCs, which quantify the dose presented to the barrier membranes (the pulmonary or gastrointestinal mucosa, respectively), dermal dose is estimated as the dose that crosses the skin and is systemically absorbed. For this reason, oral toxicity values must be adjusted to reflect the dermally absorbed dose.

Dermal RfD values and SFs are derived from the corresponding oral values. In the derivation of a dermal RfD, the oral RfD is multiplied by an oral absorption factor (ABF), expressed as a decimal fraction. The resulting dermal RfD is based on the absorbed dose and is an appropriate value for comparison to a dermal dose because dermal doses are expressed as absorbed rather than administered (intake) doses. For the same reasons, a dermal SF is derived by dividing the oral SF by the ABF. The oral SF is divided rather than multiplied because SFs are expressed as reciprocal doses.

According to Appendix A of RAGS Part A, in the absence of specific data, an assumption of 5% oral absorption efficiency is a relatively conservative assumption. In the absence of specific data, USEPA Region IV suggests an oral-to-dermal ABF of 80% for VOCs, 50% for SVOCs and 20% for inorganic chemicals (USEPA Region IV, 1994a). These percentages (or associated fractions) were used in the HHRA and are reflected in the applicable risk/hazard results.

Carcinogenic Effects of Chemicals

The risk attributed to carcinogenic exposure is estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. In the low-dose range, which would be expected for most environmental exposures, cancer risk is estimated from the following linear equation (USEPA, 1989a):

$$ILCR = (CDI)(SF)$$

where:

ILCR	=	incremental lifetime excess cancer risk, a unitless expression of the probability of developing cancer, adjusted for reference incidence
CDI	=	chronic daily intake, averaged over 70 years (mg/kg-day)
SF	=	cancer slope factor $(mg/kg\text{-}day)^{-1}$

For a given pathway with simultaneous exposure of a receptor to several carcinogens, the following equation is used to sum cancer risks:

$$Risk_p = ILCR(chem_1) + ILCR(chem_2) + \ldots ILCR(chem_i)$$

where:

$Risk_p$	=	total pathway risk of cancer incidence
$ILCR(chem_i)$	=	incremental lifetime excess cancer risk for a specific chemical

Cancer risk for a given receptor across pathways and across media is summed in the same manner.

Noncarcinogenic Effects of Chemicals

The risks associated with the noncarcinogenic effects of chemicals are evaluated by comparing an exposure level or intake with a reference dose. The HQ, defined as the ratio of intake to RfD, is defined as (RAGS, Part A):

$$HQ = CDI/RfD$$

where:

HQ	=	hazard quotient (unitless)
CDI	=	intake of chemical (mg/kg-day)
RfD	=	reference dose (mg/kg-day)

Chemical noncarcinogenic effects are evaluated using chronic RfD values. An HQ of unity or 1 indicates that the estimated intake equals the RfD. If the HQ is greater than unity, there may be a concern for potential adverse health effects.

In the case of simultaneous exposure of a receptor to several chemicals, an HI will be calculated as the sum of the HQs by:

$$HI = HQ_1 + HQ_2 + \ldots HQ_i$$

where:

HI	=	Hazard Index (unitless)
HQ	=	Hazard Quotient (unitless)

Risk and hazard projections are summarized in tables on a medium-specific basis following the general discussions of risk and hazard quantification methods. For most SWMUs and AOCs, the following subsections are included.

6.1.5.1 Surface Soil Pathways

This section of each HHRA summarizes estimated surface soil risk/hazard for each receptor group. In addition, the primary contributors to carcinogenic risk and/or noncarcinogenic hazard are discussed.

6.1.5.2 Groundwater Pathways

This section of each HHRA includes a summary of estimated groundwater risk/hazard for each receptor group. In addition, the primary contributors to carcinogenic risk and/or noncarcinogenic hazard are discussed.

6.1.5.3 Other Applicable Pathways

This section appears in HHRA for sites where pathways other than soil and groundwater were identified. It summarizes estimated risk/hazard for each receptor group. In addition, the primary contributors to carcinogenic risk and/or noncarcinogenic hazard are discussed.

6.1.5.4 COCs Identified

This section summarizes the outcome of risk/hazard projections by identifying COCs for each impacted environmental medium. COCs are identified for each medium based on cumulative (all pathway) risk and hazard projected for each site, and are displayed in tables as appropriate. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard index threshold of 1.0 (unity). In Zone H HHRAs, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a cumulative hazard index above 1.0, if its individual ILCR exceeds 1E-6 or its hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative because a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) is generally recognized by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process.

Under the traditional risk-based COC trigger provisions, no carcinogenic COCs would be identified for a particular receptor group/pathway combination if the overall cumulative site risk is less than 1E-4. However, as described previously, the cumulative risk threshold used to identify COCs in the following HHRAs is two orders of magnitude more conservative, 1E-6.

6.1.5.5 Risk/Hazard Maps

In addition to the standard tabular presentation of risk/hazard, summary risk and hazard point maps were plotted (where appropriate) for applicable environmental media. When they are used in an RFI, contour or point maps are generally developed to show the distribution and concentration of individual chemicals or groups of chemicals, or the associated risk/hazard associated with potential exposure through applicable pathways.

As an extension of conventional risk/hazard determinations, risk and hazard were calculated based on each COC's concentration at each sample location. Maps were constructed for each combination of SWMU/AOC, medium, and pathway for which sufficient data were available to produce relevant presentations. Maps and other graphics were prepared only when they were considered a useful aid in data interpretation and/or CMS decision-making. If COCs were not identified in the HHRA for a specific site or an adequate explanation could be provided in narrative form, risk contours were not developed for that site.

Surfer for Windows and ArcView, standard graphical data presentation and geographic information system packages, were used to plot the risk/hazard projections on SWMU/AOC maps. Mapping Risk Hazard (Section 6.1.6.7) describes the method used to locate the contours (where applicable), and discusses the mapping process uncertainties. The maps illustrate risk or hazard associated with COCs in the subject medium. The risk and hazard for individual locations were based exclusively on chemicals detected. For shallow groundwater (where applicable), maps address first- and second-quarter analytical results to show any temporal variability in risk or hazard associated with fluctuations in related COC concentrations. Tables summarizing the data used to generate graphical presentations are also provided. This information allows the reviewer to determine the nature of the contaminants identified and also facilitates remedial alternatives screening as part of the CMS.

6.1.6 Risk Uncertainty

This section of the HHRA presents and discusses the uncertainty and/or variability inherent in the risk assessment process in addition to medium-specific and exposure pathway-specific influences. Risk assessment sections are discussed separately below, and specific examples of uncertainty sources are included where appropriate.

6.1.6.1 General

Uncertainty is a factor in each step of the exposure and toxicity assessments summarized in the preceding sections. Overall, uncertainties associated with the initial stages of the risk assessment process become magnified when they are combined with other uncertainties. Together, the use of high-end estimates of potential exposure concentrations, frequencies, durations, and rates leads to conservative estimates of CDI. Toxicological values for chemicals derived from USEPA databases and other sources are generally derived from animal studies. Uncertainty and modifying factors are applied to extrapolate the results of these studies to predict potential human responses providing a margin of safety based upon confidence in the studies. During the risk characterization process, individual chemical risk is added to determine the incremental excess cancer risk for each exposure pathway. If the individual exposure predictions were based on the upper limit estimates of exposure to each chemical, the margin of safety of the cumulative incremental risk is the sum of all the individual safety margins applied throughout the process.

Use of these safety margins during all exposure and risk/hazard computations provides an extremely conservative means of predicting potential human health effects. The margins of safety conservatisms inherent in each step of the HHRAs are addressed in the risk uncertainty discussion. It is not possible to eliminate all uncertainties or potential variability in the risk assessment process; however, recognizing the influences of these factors is fundamental to understanding and subsequently using risk assessment results.

The risk uncertainty section of each HHRA presents the uncertainty and/or variability of site-specific and medium/pathway-specific factors introduced as part of the risk assessment process, in addition to other factors influencing the uncertainty of the calculated incremental excess cancer risks and HQs/HIs. Calculated risk/hazard levels reflect the underlying variability of the analytical results they are based on; they also embody uncertainty about potentially unsampled maxima and minima in the analytes. It is important to note that the exposure pathways considered for selection in the exposure assessment section of the HHRAs are extremely conservative.

Assumptions are made as part of the risk assessment process based on population studies and USEPA guidance. This guidance divides the assumptions into two basic categories: the upper bound (90 to 95th percentile) and the mean or 50th percentile central tendency (CT) exposure assumptions. As discussed in the Exposure Assessment section, the RME exposure is based on the upper-bound assumptions, and CT exposure is based on mean assumptions. Therefore, risk and hazard calculated using RME exposure assumptions are generally overestimates rather than underestimates. The following paragraphs discuss sources of uncertainty and variability pertinent to each exposure pathway evaluated.

6.1.6.2 Quality of Data

Data collected during the investigation of Zone H are presented in Section 4 of this RFI, which includes results from 30 AOC and SWMU sites and the QA/QC of those data. Data are validated to verify that the QC requirements of the dataset have been met and to characterize the weakness of questionable data.

Environmental samples were collected at Zone H sites from August 1994 to June 1995 (excluding the later quarterly groundwater sampling rounds). All samples were analyzed by Pace Laboratories, except nine confirmatory samples analyzed for dioxins at Southwest Laboratories. At a minimum 100% of the samples were reported using USEPA DQO Level III, while 10% were analyzed for Appendix IX parameters using USEPA DQO Level IV. The analytical methods and DQO laboratory deliverables are summarized on Table 6.1 in the Data Validation Summary, Appendix K and Table 4.2 in Section 4.

Most Zone H data were deemed usable for risk assessment as qualified. Polychlorinated dibenzodioxin and dibenzofuran data for some samples were qualified as EMPC, indicating that the reported values may be positively biased. As a result, all exposure predictions made using data so qualified should be considered absolute maxima.

Most analytical results for environmental samples have inherent uncertainty. This uncertainty is a function of the matrix characteristics and heterogeneity and the precision and accuracy of sampling, preparation, and analytical methods. Although data are typically considered to be exact values, they are the laboratory's best estimate within a range defined by method control limits. As a result, reported concentrations for any chemical can be under or overestimates of actual concentrations.

6.1.6.3 Identification of COPCs

Rather than addressing risk/hazard for all chemicals detected, screening values were used to focus the HHRA on pathways of concern and COPCs which individually exceed 1E-6 risk or an HQ of 0.1.

Exposure Pathways and Contaminants

As discussed previously, each exposure medium was compared using the most conservative screening value (residential land use) provided by USEPA. Many CPSSs were eliminated from the formal assessment on this basis. Much uncertainty has been alleviated by using the maximum detected concentrations in the screening comparison, together with low range risk/hazard goals. More constituents would have to be present at near-RBC concentrations to raise a concern for cumulative effects. Although the screening method is highly conservative, inhalation and dermal exposure are not incorporated into the soil screening values calculated by USEPA. If these pathways were the primary concern (as opposed to ingestion), the screening method could eliminate contaminants that should be considered COPCs. Based on evaluation of Zone H surface soil data, it was determined that VOCs were not widespread. Soil-to-air cross-media transport (via volatilization) was identified as a possible concern at SWMU 14 only as discussed in Section 5.3. Therefore, omission of the indirect air pathway from the process of developing the risk-based screening concentrations did not adversely affect their use.

Comparison to Reference Concentrations (Background)

Because the intent of the HHRA is to estimate the excess cancer risk or health hazard posed by COPCs, a comparison of individual site data values of inorganic chemicals were compared to background reference concentrations in the RFI for Zone H subsequent to comparing the data to screening values. As a corollary background screening method, the Wilcoxon rank sum test was used to compare inorganic COPC data populations at individual sites with corresponding reference data populations. Results of the fixed point and Wilcoxon tests were used to determine whether the concentrations differed significantly between onsite and background locations.

Additional uncertainty is introduced by comparing data to nonspecific screening reference data. Although the background concentrations are specific to Zone H, they are not individual SWMU-specific or AOC-specific. However, the large number of background samples and sample locations in Zone H increase confidence in the outcome of screening analyses because a larger dataset accounts more adequately for natural variability in media composition. Furthermore, the dual approach to background screening reduces the probability that a COPC would be improperly dismissed from formal assessment.

Background or non-site-related contamination was not considered in identifying organic COPCs for SWMUs or AOCs in Zone H. The most frequently identified soil pathway-related COPCs were carcinogenic PAHs which were addressed in terms of benzo(a)pyrene equivalents. The compounds that make up this group are commonly found in association with asphalt, used oils, and combustion by-products. In Zone H, all three types of cPAH sources have been present at some time. During RFI activities, cPAHs were frequently detected where surface soil samples were collected close to roadways and parking lots. Spatial analysis of cPAH detections indicated that asphaltic materials were not the sole source. In other areas, most notably combined SWMUs 9 and 14, there appears to be a correlation between elevated cPAH concentrations in surface soil and the presence of black material with the consistency of cinders.

This material, referred to as "coal clinker," has been used extensively across the zone for road base and general fill purposes. Due to its coal origins and combustion generation process, the detection of cPAHs in soil mixed with the material is not unexpected. The characteristics of the material including a cinder consistency would tend to minimize coingestion with native soil. The material was present at the surface in some areas and buried beneath more recent soil fill in others. As a result, it was not possible to construct a comprehensive coal clinker distribution map.

Elimination of Essential Nutrients

In accordance with RAGS, the following nutrients were eliminated from Zone H HHRAs: calcium, sodium, potassium, magnesium, and iron. Toxicity from overexposure to the nutrients listed above is possible only if human receptors are exposed to extremely high doses. USEPA recommends eliminating these compounds from formal risk assessment. Because no screening comparison was performed, the HIs calculated in the HHRAs could be positively influenced by the nutrient concentrations detected onsite. Therefore, the HIs are possibly underestimates.

6.1.6.4 Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions in the site-worker scenario are highly conservative and would tend to overestimate exposure. Current site workers are not exposed to site groundwater. They are infrequently exposed to surface soil when walking across the site, using commercial facilities, or mowing the grass. Site workers would not be expected to work in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. Mowing grass 52 days per year would result in one-fifth the projected risk/hazard for site workers.

Residential use of the sites in Zone H would not be expected, based on current site uses and the nature of surrounding buildings. Furthermore, current base reuse plans call for continued use of Zone H as nonresidential property. These plans show most of the zone as mixed commercial/industrial use with limited open areas for recreation. If this area were developed as residential sites, most of the present buildings would be demolished and the surface soil conditions would likely change — the existing soil could be covered with roads, paved driveways, landscaping soil, and/or houses, or they could be made into playgrounds. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways in the HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

To more accurately assess potential exposure under current site conditions, existing features were evaluated to determine whether they might preclude or minimize contact. Asphalt parking/road surfaces, buildings, and concrete slabs are features under which soil samples were collected.

Assuming the future site use involves maintaining these structures, onsite workers would not be chronically exposed to soil beneath them. These factors were considered in calculating alternative EPCs for SWMUs/AOCs with significant surface features (where applicable) and generating descriptive text where formal analysis was deemed unnecessary.

Where chronic RME estimates of risk/hazard indicate that a significant threat would be posed to human health, CT was analyzed. CT exposure scenarios were constructed consistent with standard exposure assumptions as provided in *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure-Draft*, (USEPA, 1993).

Groundwater is not currently used in Zone H as a source of potable or process water. A basewide system provides drinking and process water to buildings throughout Zone H. This system is to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

In addition, the shallow aquifer, monitored during the RFI process, naturally contains significant concentrations of chlorides and dissolved solids. As a result, the potential utility of this water-bearing zone as a source of potable water is questionable. Absent potential potable uses, the applicability of tap water-based screening or remedial standards is questionable. Figure 6.1.3 shows shallow monitoring wells in Zone H which contain chlorides in excess of 250 mg/L during the first two quarterly monitoring events.

Determination of Exposure Point Concentrations

Based on the guidance provided by USEPA, EPCs are concentrations used to estimate CDI. The uncertainty associated with EPCs stems primarily from their statistical determination or the imposition of maximum concentrations, described below.

NOTE: Wells shown produced at least one quarterly GW sample with a concentration greater than 250 mg/L Chlorides

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 6.1.3
NAVBASE-CHARLESTON
ZONE H
SHALLOW GROUNDWATER
CHLORIDES CONCENTRATION

DATE: 06/10/96	PROJ NAME: CHLORIDE.APR

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Statistical Estimation of Exposure Point Concentrations

USEPA's *Supplemental Guidance to RAGS: Calculating the Concentration Term* (1992c) guidance document outlines a statistical estimation of EPC. These calculated concentrations are 95th percentile UCLs on the mean which are based on certain assumptions. USEPA assumes that most (if not all) environmental data are lognormally distributed. This assumption can lead to over- or underestimation of the concentration term because many environmental data are neither normally nor lognormally distributed.

The UCL calculation method is provided in the *Supplemental Guidance to RAGS: Calculating the Concentration Term*. This calculation includes a statistical value, the H-statistic, which is based on the number of samples analyzed for each COPC and the standard deviation of the results. To obtain this number, a table must be referenced, and the value must be interpolated (estimated) from the table. The equation for the H-statistic has not been provided in the supplemental guidance, nor does the document referred to in the guidance provide the equation. Although the statistic appears to be nonlinear, a linearity assumption was made to facilitate interpolation of the statistic for each COPC addressed in the HHRA.

Linear interpolation is a good estimate of H; however, it is important to note that the UCL formula and H are natural log values. The effect of multiplying natural log numbers is not equivalent to multiplying untransformed values. When data are log-transformed, adding two numbers is the equivalent of multiplying the two numbers if they were not transformed. The effect of multiplying a number while in log form is exponential; and here, H is applied as a multiplier. In summary, using this method to calculate the UCL has the effect of overestimating, and often provides concentrations greater than the maximum detected onsite. For all datasets having less than 10 total samples for a specific medium, the maximum concentrations detected were used as EPC. The datasets in these risk assessments are generally small; however, most consisted of 10 or more samples and the UCL was calculated for those groups. The limited number of soil and groundwater samples used to assess site conditions often resulted in considerable variability between data points, and thus relatively high standard deviations about the mean. The high standard deviation results in elevated UCL projections.

Although RAGS advocates using neither worst-case scenarios nor maximum concentrations as EPCs, the use of the H-statistic often necessitates using the reported maximum concentration as the EPC. In accordance with RAGS, the lesser of either the maximum concentration or the UCL is used as the EPC. As reviewed above, summation of risk based on maximum concentrations leads to overestimation of exposure, especially in the case of low detection frequency or spatially segregated COPCs. This concept is further discussed below.

Frequency of Detection and Spatial Distribution

Because of the influence of standard deviation on EPC, low frequency of detection can cause COPCs to be addressed inappropriately in the risk assessment. More specifically, COPCs detected only once or twice in all samples analyzed (having concentrations exceeding the RBCs and reference concentrations) would be expected to have relatively higher standard deviation as concentration variability or range widens. Higher standard deviation results in a high H-statistic, and this typically leads to a UCL greater than the maximum concentration detected onsite. If that is the case, then using the UCL or maximum concentration detected as EPC (or possibly the inclusion of the COPC in question) may not be appropriate when EPC is assumed to be widely distributed. It is not feasible for a receptor to be simultaneously exposed to maximum concentrations of different contaminants at several locations. The use of the maximum concentrations (or the UCL) is questionable for these contaminants, and the calculated risk and hazard could be skewed upward or downward due to the low frequency of detection.

In some instances, hot spots can be defined within the investigation area. A hot spot is an isolated area of concentrated contamination within a larger area which is not impacted or not impacted as much as the hot spot. Exposure quantification in the presence of a hot spot may be achieved by calculating a fraction ingested/fraction contacted (FI/FC) from contaminated

For most sites, point maps were constructed to show the cumulative risk/hazard computed at a specific point based on the location-specific data for the medium of interest. There were, however, instances where contouring of the projected risk/hazard values was considered useful with respect to scoping corrective measures. The following paragraphs discuss how contour maps were produced as well as sources of uncertainty inherent in any interpolation contouring process.

Contouring involves fitting isolines of elevation, concentration, risk, etc. to a scattered or gridded set of points with known values. The graphical result estimates a continuous surface. Because values are known at only a few of an infinite number of possible points on the surface, the mapping process involves extensive interpolation between known points to give estimated values.

Of many possible interpolation methods, kriging is, statistically, the best linear unbiased estimator. It estimates more accurately than other methods because it accounts for the variance of the underlying data values versus the distance between the data points. The relationship between variance and distance is modeled for each dataset using a variogram, and the model serves to differentially weight the data from nearby points with known values that are used to estimate values at unmeasured points (i.e., points whose values must be interpolated between known points). Recognized spatial trends in the data can be accommodated by specifying a *drift* (linear, quadratic, etc.), while any known error variance in the data allows use of a *nugget value* when determining the type of variogram model to be used. Risk/hazard contour maps for this RFI report were generated using Surfer for Windows' default linear variogram model with no drift specified. The nugget value is automatically set to zero for the linear model.

Any method of contour mapping, manual or automatic, involves extensive estimation of values at unmeasured points. The mapping process itself is a generalization, in that it converts point data to area (surface) data. The resulting mapped surfaces are known to be accurate only near the control points (that is, within and immediately around the AOCs/SWMUs); accuracy decreases dramatically where there are large spatial distributions between clusters of points, as in parts of Zone H. In these areas, the maps should be considered rough indicators of trends, rather than reliable sources of accurate data values at specific points.

Risk and hazard projection mapping is useful in risk assessment for determining whether hot spots (or isolated areas of gross contamination) exist within an otherwise unimpacted area. This is important, as the lack of homogeneous contaminant concentrations can affect the manner in which receptors are exposed to the affected media. As discussed earlier, it is sometimes appropriate to estimate the fraction ingested/contacted from the contaminated source (FI/FC factors) in computing CDI. Contour maps allow for visual analysis of contaminant distributions and facilitate estimation of the extent of hot spots relative to the overall site area. These maps also support preliminary scoping of remedial requirements as well as assessment of potential cleanup alternatives in the CMS.

As discussed above, lower confidence can be placed in the concentration estimates made by the kriging function (as represented by contours) in low sample density areas. Because the RFI focused on AOCs/SWMUs, concentrations of background samples that were collected between the sites were not incorporated into the contours, although these areas could influence risk/hazard plots developed for Zone H. The distribution of samples and/or data precluded meaningful graphical presentations at many AOCs/SWMUs. Because of the lack of calculated values for surrounding background locations, relatively planar risk/hazard results were computed for some AOC/SWMU and media combinations. Essentially flat plots would be of little use in interpreting risk/hazard projections. As a result, graphical outputs which fit this description were not generated, and narrative discussions of contaminant distribution are provided. The contour maps presented in Section 6.2 represent the spatially distributed risk and/or hazard of COCs identified in the risk assessment.

6.1.7 Risk Summary

In each site-specific HHRA, this section summarizes risk and hazard projected for each receptor group, exposure medium, and exposure pathway.

6.1.8 Remedial Goal Options

RGOs are chemical concentrations computed to equate with specific risk and/or hazard goals that may be established for a particular site. As previously discussed, COCs are identified as any COPC that significantly contributes to a pathway of concern. A pathway having an ILCR greater than 1E-6 or HI greater than 1 is defined as a pathway of concern, and an individual chemical that contributes either 1E-6 ILCR or 0.1 HI is considered a significant contributor. Based on this method, COCs were identified which required calculation of RGOs. These are listed in the Risk Characterization section of the HHRA for each site. RGOs were calculated for all COPCs contributing to a pathway risk of 1E-6 or greater. Inclusion in the RGO table does not necessarily indicate that remedial action will be required to address a specific chemical. Instead, RGOs are provided to facilitate risk management decisions.

In accordance with USEPA Supplemental RGO Guidance (USEPA Region IV, 1994b), RGOs were calculated at 1E-4, 1E-5, and 1E-6 risk levels for carcinogenic COCs and HQ goals of 3, 1, and 0.1 for noncarcinogenic COCs. RGOs for carcinogens were based on the lifetime weighted average and the adult site worker. Groundwater RGOs for the site resident and site worker are presented in separate tables (where applicable) in each site-specific HHRA. Hazard-based RGOs were calculated based on either the hypothetical child resident or the adult site worker, as noted in the each of the corresponding tables.

Table 6.1.1
Parameters Used to Estimate CDI at RME

Pathway Parameters	Resident Adult	Resident Child	Adult Worker	Units
Surface Soil Ingestion and Dermal Contact				
Ingestion Rate (soil)	100[(a)]	200[(a)]	50[(a)]	mg/day
Ingestion Rate (water)	2	1	1	L/day
Exposure Frequency	350[(b)]	350[(b)]	250[(b)]	days/year
Exposure Duration	24[(c)]	6[(c)]	25[(c)]	years
Dermal Contact Area	4,100[(d)]	2,900[(d)]	4,100[(d)]	cm^2
Skin Adherence Factor	1	1	1	mg/cm^2
Absorbance Factor	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	unitless
Dermal Adjustment Factor	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	unitless
Conversion Factor	1E-6	1E-6	1E-6	kg/mg
Body Weight	70[(a)]	15[(a)]	70[(a)]	kg
Averaging Time, Noncancer	8,760[(e)]	2,190[(e)]	9,125[(e)]	days
Averaging Time, Cancer	25,550[(f)]	25,550[(f)]	25,550[(f)]	days

Notes:

(a) = USEPA (1989a) *Risk Assessment Guidance for Superfund Vol. I: Human Health Evaluation Manual (Part A).*

(b) = USEPA (1991b) *Risk Assessment Guidance for Superfund Vol. I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors, Interim Final,*

(c) = USEPA (1991a), *Risk Assessment Guidance for Superfund: Vol. I: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals).*

(d) = Resident Adult accounts for head, hands, and forearms at 90th percentile values from Table 4B-1, *Exposure Factors Handbook* (USEPA, 1989d) ; assumes individual is clothed with shoes, long pants, and short sleeves; rounded up from 4,090 cm^2.
Resident Child accounts for head, hands, forearms, lower leg, and feet using 90th percentile total body surface area values for male children 1-6 years of age (6,000 cm^2 assumed for 1-2 year old); because individual body part information is not available for 5-6 year olds, mean of other groups was assumed. Forearm surface area set equal to 46% of full arm; lower leg set equal to 41% of full leg measurement.

(e) = Calculated as the product of exposure duration (years) x 365 days/year.

(f) = Calculated as the product of 70 years (assumed lifetime) x 365 days per year.

6.2 Site-Specific HHRA

The following sections present the HHRAs prepared for individual SWMUs and AOCs, and each SWMU/AOC grouped for the RFI. The HHRA were organized as described in the following paragraphs.

SWMU 9 (Includes SWMUs 19, 20, 121 and AOCs 649, 650, 651 and 654)

These locations were grouped because they are close to SWMU 9 proper (the former mixed waste landfill). For the HHRA, soil-related pathways were addressed on SWMU or AOC-specific basis. Shallow and deep groundwater were addressed for the entire area with no distinctions made relative to individual SWMUs or AOCs.

SWMU 13

No other SWMUs/AOCs were included in the assessment for SWMU 13.

SWMU 14 (Includes SWMU 15 and AOCs 670 and 684)

This grouping was made because of SWMU 15 and AOCs 670 and 684 are close to SWMU 14 proper (the chemical disposal area). For the HHRA, soil-related pathways were addressed on a SWMU- or AOC-specific basis. Shallow and deep groundwater were addressed for the entire area with no distinctions made relative to individual SWMUs or AOCs.

SWMUs 13, 17, 159, and 178; AOCs 653, 655, 656, 659, 660, 662, 665, and 666

The HHRA for each of these sites is presented in individual sections.

AOC 663/SWMU 136 and AOC 667/SWMU 138

The soil and groundwater investigations at these two sites resulted in an overlapping sampling effort. Due to their proximity and similar CPSS lists, the data for these sites were combined for use in a composite HHRA.

Other Impacted Areas

This assessment addressed three locations that were initially investigated as background grid locations (G07, G38 and G80). During the initial sampling round, results indicated that the areas had been impacted. Supplemental samples were collected and human health risk assessments were performed for each. Although these areas are not necessarily close to one another, they were addressed as a group due to similarities in origin. The assessments were based on data specific to each location.

The HHRA for each SWMU, AOC, or group are presented in the following sections. The tables for each SWMU/AOC specific HHRA immediately follow the susection in which they were referenced and in the order they were referenced.

source factor based on the percentage of the total exposure area encompassed by the hot spot, then using this term to modify the maximum (or restricted area average) contaminant concentration to derive the EPC. Risk and hazard map presentations were used to determine the percent area affected at more complex sites.

6.1.6.5 Toxicity Assessment Information

There is a generally recognized uncertainty in human toxicological risk values developed from experimental data primarily due to the uncertainty of data extrapolation in the areas of high- to low-dose exposure and animal data to human experience. The site-specific uncertainty is mainly in the degree of accuracy of the exposure assumptions. Most of the assumptions used in this and any risk assessment have not been verified. For example, the degree of chemical absorption from the gut or through the skin or the amount of soil contact is not known with certainty.

The uncertainty of toxicological values from the IRIS and HEAST databases provided by USEPA is summarized (where available) in each human health risk assessment. The uncertainty factors assigned to these values account for acute to chronic dose extrapolation, study inadequacies, and sensitive subpopulations among other factors. Although uncertainty factors for a specific compound may be 1,000 or higher, these safety factors are applied by USEPA to assist in guaranteeing that the overall assessment of risk/hazard is conservative toward human health concerns. In the presence of such uncertainty, the USEPA and the risk assessor are obligated to make conservative assumptions so that the chance is very small for the actual health risk to be greater than what is determined through the risk assessment process. On the other hand, the process is not intended to yield overly conservative risk values that have no basis in actual conditions. This balance was considered in developing exposure assumptions and pathways and in interpreting data and guidance for Zone H HHRAs.

Evaluation of Dioxin Congeners as 2,3,7,8-TCDD Equivalents

Where chlorinated dibenzodioxins and dibenzofurans (dioxins) were identified in soil, 2,3,7,8-TCDD equivalent concentrations were derived by multiplying the concentration of each dioxin congener by its corresponding USEPA TEF. The resulting TEQs were then summed for each sample, and the total was compared to the 1 μg/kg AL. If the total TEQ value was less than 1 μg/kg, it was concluded that soil dioxins do not pose an unacceptable risk. Groundwater exposure quantification was performed using TEQ values computed for each individual monitoring point.

Evaluation of Chemicals for Which No Toxicity Values Are Available

In addition to the typical uncertainties inherent in toxicity values, parameters which do not have corresponding RBCs due to the lack of approved toxicological values were not included in the CDI calculation data. This does not indicate that chemicals lacking approved toxicological values pose no risk/hazard. As stated previously, essential nutrients were eliminated based on their low potential for toxicity. Therefore, these chemicals were not assessed further in the HHRA.

6.1.6.6 Quantification of Risk/Hazard

This section of each HHRA is reserved for discussion of potential sources of uncertainty or variability identified in the quantification of risk and hazard that are not covered in preceding sections. Each exposure medium formerly assessed is briefly discussed.

6.1.6.7 Mapping Risk/Hazard

Included in Section 6.2 are summary risk and hazard maps developed to present HHRA results. Location-specific totals were summed and plotted to illustrate total risk and/or total hazard at sites where data supported such a representation. Section 6.1.5.5 presents methods used to construct the risk/hazard maps.

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
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6.2.1 Baseline Risk Assessment for SWMU 9

6.2.1.1 Site Background and Investigative Approach

The focus of the investigation at combined SWMU 9 (which includes SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654) was the assessment of soil and groundwater potentially affected by past site activities. SWMU 9, a mixed-use landfill that was closed in 1973, and its associated sites has been the focus of previous assessments and/or investigative activities. Site histories and uses are detailed in Section 6.2.1.3. The following paragraphs summarize the RFI samples collected in each investigative area.

Soil

SWMU 19

Table 6.2.1.1 shows surface soil sample locations and the analytical methods used for the 18 samples collected at this site.

SWMU 20

Table 6.2.1.2 shows surface soil sample locations and the analytical methods used for the 11 samples collected at this site.

SWMU 121

Table 6.2.1.3 shows surface soil sample locations and analytical methods used for the 17 samples collected at this site. One sample was analyzed for dioxin only.

AOC 649

Table 6.2.1.4 shows surface soil sample locations and analytical methods used for the 10 samples collected at this site.

AOC 650

Table 6.2.1.5 shows surface soil sample locations and analytical methods used for the nine samples collected at this site.

AOC 654

Table 6.2.1.6 shows surface soil sample locations and analytical methods used for six samples collected at this site.

Groundwater

Groundwater samples collected from 21 shallow and eight deep zone monitoring wells were analyzed for parameters similar to those for soil samples. The lists of first-quarter shallow and deep groundwater samples and corresponding analyses are shown in Tables 6.2.1.7 and 6.2.1.8, respectively. Second-quarter shallow and deep groundwater samples and corresponding analyses are shown in Tables 6.2.1.9 and 6.2.1.10, respectively.

Soil sample locations at SWMU 9 were named on an individual site basis (SWMU 19, SWMU 121, AOC 650, etc.), and analytical results are presented in the tables accordingly. In contrast, groundwater monitoring wells at SWMU 9 were all assigned "009" as part of their location designations, except one shallow well at SWMU 121, and results are presented in single lists for each quarterly monitoring event and depth interval.

6.2.1.2 COPC Identification

Soil

SWMU 19

Table 6.2.1.11 shows surface soil COPCs identified at this site. Antimony, Aroclor-1254, Aroclor-1260, arsenic, BEQs, beryllium, copper, lead, nickel, and zinc were identified as COPCs based on the RBC comparison. Arsenic, copper, lead, nickel, and zinc were identified as COPCs based on the UTL comparison, and copper, lead, nickel, and zinc were identified as

COPCs based on the Wilcoxon rank sum test, the results of which are presented in Appendix J. Of two samples analyzed for TPH, concentrations exceeding 100 mg/kg (170 to 189 mg/kg) were reported at two sample locations within SWMU 19.

SWMU 20

Table 6.2.1.12 shows surface soil COPCs identified at this site. BEQs were identified as COPCs based on the RBC comparison, but no COPCs were identified based on either the UTL comparison or the Wilcoxon rank sum test, the results of which are presented in Appendix J. SWMU 20 surface soil was not analyzed for TPH.

SWMU 121

Table 6.2.1.13 shows surface soil COPCs identified at this site. Antimony, Aroclor-1254, Aroclor-1260, arsenic, BEQs, beryllium, copper, lead, nickel, and zinc were identified as COPCs based on the RBC comparison. Arsenic, beryllium, copper, lead, nickel, and zinc were identified as COPCs based on the UTL comparison, and beryllium, copper, lead, nickel, and zinc were identified as COPCs based on the Wilcoxon rank sum test, the results of which are presented in Appendix J. TPH was reported at 150 mg/kg in the one sample at SWMU 121.

AOC 649

Table 6.2.1.14 shows surface soil COPCs identified at this site. BEQs and mercury were identified as COPCs based on the RBC and UTL comparison, but no COPCs were identified based on the Wilcoxon rank sum test, the results of which are presented in Appendix J. TPH in AOC 649 and 650 surface soil ranged from 160 to 980 mg/kg based on two samples analyzed.

AOC 650

Table 6.2.1.15 shows surface soil COPCs identified at this site. Aroclor-1254, BEQs, and copper were identified as COPCs based on the RBC comparison. Copper was also identified as a COPC based on comparison to the UTL. No COPCs were identified based on the

Wilcoxon rank sum test, the results of which are presented in Appendix J. TPH in AOC 649 and 650 surface soil ranged from 160 to 980 mg/kg based on two samples analyzed.

AOC 654

Table 6.2.1.16 shows no surface soil COPCs were identified at this site. One surface soil sample was analyzed for TPH at AOC 654, and none was reported.

Based on the screening comparisons described in Section 6.1.3.4 of this report, the focus of this BRA pertaining to surface soil is on the COPCs shown in Tables 6.2.1.11 through 6.2.1.16 which correspond with SWMUs 19, 20, and 121 and AOCs 649, 650, and 654, respectively. Because AOC 651 overlaps AOCs 649 and 650, its samples were grouped with either AOCs 649 or 650. Therefore, a separate screening table was not developed for AOC 651. No COPCs were identified at AOC 654, and consequently, AOC 654 was not assessed further for to potential soil exposure pathways.

In addition to risk-based screening, contaminant concentrations were compared to background using two parallel statistical tests. Methods and a results summary of background UTLs and the Wilcoxon rank sum test are presented in Appendix J. Wilcoxon rank sum test results generally indicated that there was no significant difference between group sample concentrations at SWMU 9 sites and background concentrations for any inorganic constituent.

Groundwater

COPCs identified in first- and second-quarter shallow groundwater for SWMU 9 are shown in Tables 6.2.1.17 and 6.2.1.18, respectively. COPCs identified in first- and second-quarter deep groundwater for SWMU 9 are shown in Tables 6.2.1.19 and 6.2.1.20, respectively. Results of Wilcoxon rank sum tests indicate that, of the inorganic chemicals in Table 6.2.1.17, barium concentrations were significantly higher than background (with over 99% confidence) at

SWMU 9, while lead concentrations were not significantly higher than background (test results are presented in Appendix J).

First-Quarter Shallow Groundwater

Table 6.2.1.17 presents the COPCs identified based on RBC comparisons. In addition to the risk-based comparisons, barium and lead were identified as COPCs based on the UTL comparison. Vanadium was also identified as a COPC based on the Wilcoxon rank sum test (Appendix J).

Second-Quarter Shallow Groundwater

Table 6.2.1.18 presents the COPCs identified based on RBC comparisons. Barium and lead were identified as COPCs based on the UTL comparison, and vanadium was also identified as a COPC based on the Wilcoxon rank sum test (Appendix J).

First-Quarter Deep Groundwater

Table 6.2.1.19 presents the COPCs identified based on RBC comparisons. No COPCs were identified as COPCs based on either the UTL comparison or the Wilcoxon rank sum test (Appendix J). Because manganese concentrations reported for deep groundwater exceeded the UTL, manganese was included as a COPC.

Second-Quarter Deep Groundwater

Table 6.2.1.20 presents the COPCs identified based on RBC comparisons. No COPCs were identified based on either the UTL comparison or the Wilcoxon rank sum test (Appendix J). Because manganese concentrations reported for deep groundwater exceeded the UTL, manganese was included as a COPC.

6.2.1.3 Exposure Assessment

Exposure Setting

The exposure setting at SWMU 9 is a closed mixed-use landfill that operated from the 1930s until 1973. This combined site includes eight AOCs/SWMUs (SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654) that are within the landfill boundary and therefore, will be included in this review process. The landfill reportedly contains asbestos, varnish sludge, mercury, electroplating waste, paint wastes, PCBs, and medical wastes. Solid waste was reportedly disposed directly into tidal marshes. Additionally, the waste was sometimes burned to reduce volume.

SWMU 9 also contains a solid waste transfer station (SWMU 19) for temporary storage of solid waste prior to offsite disposal. The mixed waste was formerly stored on bare ground, but is now containerized.

SWMU 20 is the site of previous waste disposal and storage area. For several years starting in 1985, batteries, concrete, wood, sandblasting residue, and other waste were stored on the bare ground, with no containment.

SWMU 121 encompasses Building 801 and an associated SAA. For the past six years, Building 801 has been used to collect, sort, and store recyclables. The associated SAA was an 8-foot by 8-foot sheet metal building with a concrete floor and no secondary containment. It stored hazardous waste, including paint, used oil, and automotive batteries.

AOCs 649, 650, and 651 stored wastes and products for subcontractors such as Metal Trades, Inc., Sandblasters, Inc.; and Braswell Shipyards. These storage areas contained welding supplies, abrasive materials for sandblasting, and metal product waste material from the 1970s until 1991.

Also within SWMU 9 is AOC 654, an abandoned septic tank connected to Building 661 and its associated drain field. This septic tank was used from 1968 until 1978 during which the raw sewage in the tank reportedly overflowed during heavy use.

The future use of the areas in SWMU 9 will be used as a buffer zone between the future cargo terminal zone, the Marine Industrial Park, and the area south of NAVBASE, according to the current base reuse plan.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed in this risk assessment. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions and the use of shallow groundwater as a potable water source. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact and the fact that groundwater is not currently used onsite. Therefore, future worker assessment is considered protective of current site users.

Exposure Pathways

Exposure pathways for future site workers are dermal contact and incidental ingestion of surface soil, and hypothetical use of groundwater as a potable water source. The exposure pathways for future residential land use (hypothetical adult and child residents) are the same as those for the future site worker. For surface soil, uniform exposure was assumed for all sample locations within each SWMU, while AOCs 649, 650, and 651 were grouped due to their proximity. Shallow and deep groundwater were assessed assuming uniform exposure across the area of SWMU 9. For each aquifer, ingestion and inhalation pathways were assessed (where appropriate). Table 6.2.1.21 justifies exposure pathways assessed in this HHRA.

Exposure Point Concentrations

As discussed in Section 6.1.4.4 of this report, UCLs were calculated for datasets consisting of at least 10 samples. Soil EPCs for SWMUs 19, 20, 121, and AOC 649 are based on UCLs, which are shown in Tables 6.2.1.22, 6.2.1.23, 6.2.1.24, and 6.2.1.25, respectively. Fewer than 10 samples delineate the extent of CPSSs detected at AOC 650, and the maximum reported surface soil COPC concentrations were used as EPC. EPCs for first- and second-quarter shallow groundwater are based on UCLs and are shown in Tables 6.2.1.26 and 6.2.1.27 in standard sitewide RME assessments. The maximum reported concentrations were used as the deep groundwater EPCs in standard sitewide RME assessments.

Quantification of Exposure

CDIs for ingestion and dermal contact with soil are shown in Tables 6.2.1.28 through 6.2.1.37.

Soil

SWMU 19

Tables 6.2.1.28 and 6.2.1.29 show surface soil CDI estimates for ingestion and dermal contact, respectively.

SWMU 20

Tables 6.2.1.30 and 6.2.1.31 show surface soil CDI estimates for ingestion and dermal contact, respectively.

SWMU 121

Tables 6.2.1.32 and 6.2.1.33 show surface soil CDI estimates for ingestion and dermal contact, respectively.

AOC 649

Tables 6.2.1.34 and 6.2.1.35 show surface soil CDI estimates for ingestion and dermal contact, respectively.

AOC 650

Tables 6.2.1.36 and 6.2.1.37 show surface soil CDI estimates for ingestion and dermal contact, respectively.

Groundwater

CDIs were estimated for each quarter and water-bearing zone (WBZ). First- and second-quarter CDIs for shallow and deep groundwater ingestion/inhalation are presented in Tables 6.2.1.38 through 6.2.1.41, respectively.

6.2.1.4 Toxicity Assessment

Table 6.2.1.42 presents a summary of toxicological risk information used in this BRA. Brief toxicological profiles for SWMU 9 COPCs are presented below.

Benzene is a VOC associated with leukemia. This chemical has been used as a solvent in coal tar naphtha, rubber, and plastic cement (Dreisbach et al., 1987). USEPA lists benzene as a group A carcinogen. As listed in IRIS (search date 6/29/95), the classification is based on several studies of increased incidence of nonlymphocytic leukemia from occupational exposure, increased incidence of neoplasia in rats and mice exposed by inhalation and gavage, and some supporting data. In large doses, benzene depresses the central nervous system (CNS), and chronic exposure depresses bone marrow. The oral SF for benzene was set by USEPA as 2.9E-2 $(mg/kg\text{-}day)^{-1}$, and a provisional oral RfD has been set at 3E-4 mg/kg-day. The inhalation RfD was 0.00171 mg/kg-day, and the inhalation SF was 0.029 $(mg/kg\text{-}day)^{-1}$. Occupational inhalation exposure to benzene is acceptable by Occupational Safety and Health

Administration (OSHA) at concentrations of 3.25 mg/m^3 or 1 ppm in air National Institute for Occupational Safety and Health (NIOSH, 1990).

Hexachlorobenzene is a VOC that targets the liver, and USEPA determined the RfD_o to be 0.0008 mg/kg-day. As discussed in IRIS (search date 6/29/95), long-term effects have been demonstrated by the epidemic of porphyria cutanea tarda (PCT) in Turkish citizens who accidentally consumed bread made from grain treated with hexachlorobenzene. Other forms of toxic effects include neurotoxicity, liver damage, reduced growth, and arthritic changes in appendages of exposed children (through both direct and indirect exposure). The uncertainty factor for this compound is 100 and the modifying factor is 1. As listed in IRIS, hexachlorobenzene has been determined to be a class B2 carcinogen, and based on induced tumors in the liver, thyroid, and kidney in three rodent species when administed orally. The SF_o was 1.6 (mg/kg-day)$^{-1}$.

1,2-Dichloroethene, or 1,2-dichloroethylene, is a halogenated hydrocarbon associated with toxicity to the mucous membrane, skin, lung, cornea (irritation), and liver. This compound is less toxic than its alkane counterparts, and is neither mutagenic nor carcinogenic (Dreisbach et al., 1987). There is no USEPA carcinogenicity listing for this compound. However, the RfD_o has been set to 0.009 mg/kg-day by USEPA (HEAST RfD_o for total 1,2-dichloroethene). As listed in IRIS (search date 6/29/95), the critical effect of this chemical is increased serum alkaline phosphatase in male mice. The uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfD for trans-1,2-dichloroethene is 0.02 mg/kg-day.

Methylene chloride, a common industrial solvent, has also been used in the post-harvest fumigation of strawberries and commodity fumigation of grains, and with ethylene for degreening citrus fruits. This compound causes CNS depression and lung and liver damage. Synergistic hepatotoxic effects are possible during corresponding exposure to enzyme inducers such as alcohols and ketones (Dreisbach et al., 1987). Methylene chloride is a USEPA class B2 carcinogen, and the SF_o and SF_i have been set by USEPA to 0.0075 and 0.00164 $(mg/kg\text{-}day)^{-1}$, respectively. As listed in IRIS (search date 6/29/95), the classification is based on inadequate human data but sufficient evidence of carcinogenicity in animals; increased incidence of hepatocellular neoplasms and alveolar/bronchiolar neoplasms in male and female mice, and increased incidence of benign mammary tumors in both sexes of rats, (salivary gland sarcomas in male rats and leukemia in female rats). This classification is supported by some positive genotoxicity data, although results in mammalian systems are generally negative. The RfD_o and RfD_i are 0.06 and 0.857 mg/kg-day, respectively. As listed in IRIS, the critical effect is liver toxicity. The uncertainty factor was 100 and the modifying factor was 1.

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an AL for soil protective of child residents has been proposed by USEPA Region IV: 400 mg/kg. USEPA's Office of Solid Waste and Emergency Response (OSWER) has recommended a 1,000 mg/kg cleanup standard for industrial properties. USEPA's Office of Water has established a treatment technique AL of 15 μg/L. As listed in IRIS (search date 10/17/95), the classification is based on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites, and sometimes lead is free-flowing. If an individual who has previously been exposed to lead loses weight, fat-bound lead can be set free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

Mercury occurs in three forms: elemental, organic, and inorganic. The major source of this element is the degassing of the earth's crust. Target organs of inorganic mercury include the kidney, nervous system, fetus, and neonate. In other words, this inorganic can be toxic to a fetus if the mother is exposed during pregnancy. Mercury is toxic to all cells in the body. It binds to enzymes in the cells and disrupts their function, usually causing the cell to become useless or die. Because this inorganic element is concentrated in the kidney prior to excretion, the kidney is a major target organ for mercury ingestion. The primary target of mercury vapor is the brain. Some forms of mercury are drawn towards fats in the body (such as the nervous system), where the chemical form is metabolized into its toxic form. This causes the nervous disorder known as Minimata disease — overexposure to mercury through ingestion of contaminated fish. At Minimata, fish ingested inorganic mercury from an industrial discharge, and the inorganic form was metabolized to organic mercury (Klaassen et al., 1986; Dreisbach et al., 1987). As listed in IRIS (search date 6/29/95), the D classification is based on inadequate human and animal data. Epidemiologic studies failed to show a correlation between exposure to elemental mercury vapor and carcinogenicity; the findings in these studies were confounded by possible or known concurrent exposures to other chemicals, including human carcinogens, as well as lifestyle factors (e.g., smoking). Findings from genotoxicity tests are severely limited and provide equivocal evidence that mercury adversely affects the number or structure of chromosomes in human somatic cells. USEPA set mercury's RfD to 0.0003 mg/kg-day (inorganic form). Mercury is liquid at room temperature, and is poorly absorbed in this form, if ingested. Typical daily exposure is less than 1 μg/L-day. As listed in IRIS (search date 6/28/95), the critical effect of this chemical is hand tremor increases in memory disturbances and slight subjective and objective evidence of autonomic dysfunction. The uncertainty factor was 30 and the modifying factor was 1. The HEAST reference concentration (RfC) is 0.0003 mg/m^3.

Vanadium is not readily absorbed through the skin or oral ingestion and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaassen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust. Typical vitamin supplements contain approximately 0.010 mg in a daily dose. The RfD_o set by USEPA is 0.007 mg/kg-day.

Vinyl chloride is a volatile organic that can cause Raynaud's Phenomenon or white finger disease. It has been shown to cause angiosarcoma, a cancer. It has been also been associated with reproductive dysfunction in men and women. The primary target organs for noncarcinogenic effects are the liver, kidney, and nervous system. This compound inhibits one of the main metabolic pathways of the body (a group of enzymes), and can influence the toxicity of other compounds because of this effect (Klaassen et al., 1986; Dreisbach et al., 1987). Due to the carcinogenicity of this compound, USEPA classified vinyl chloride as a class A carcinogen and set the SF_i and SF_o to 0.3 and 1.9 $(mg/kg\text{-}day)^{-1}$, respectively.

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a no observed adverse effects level (NOAEL) of 0.8 μg/kg-day in a human exposure study. Arsenic's effect on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingesting these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. As listed in IRIS (search date 9/1/95), the classification is based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.038 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

Beryllium exposure via the inhalation route can inflame the lungs, a condition known as Acute Beryllium Disease, as a result of short-term exposure to high concentrations. Removal from exposure reverses the symptoms. Chronic exposure to much lower concentrations of beryllium or beryllium oxide by inhalation has been reported to cause Chronic Beryllium Disease, with symptoms including shortness of breath, scarring of the lungs, and berylliosis, which is noncancerous growths in the lungs of humans. Both forms of beryllium disease can be fatal, depending on the severity of the exposure. Additionally, a skin allergy may develop when soluble beryllium compounds come into contact with the skin of sensitized individuals (Gradient, 1991). An oral RfD of 0.0054 mg/kg-day has been set for beryllium based on a chronic oral bioassay (rats were the study species) which determined no adverse effect occurs at 0.54 mg/kg-day. Beryllium has been classified by USEPA as a group B2 carcinogen based on animal studies. It has been shown to induce lung cancer via inhalation in rats and monkeys, and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. Human epidemiology studies of beryllium are inadequate. The inhalation SF of 8.4 $(mg/kg\text{-}day)^{-1}$ and the oral SF of 4.3 $(mg/kg\text{-}day)^{-1}$ have been set by USEPA. As listed in IRIS (search date 6/28/95), this chemical has no critical adverse effect. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfD in drinking water is 0.005 mg/kg-day.

Chromium exists in two stable, natural forms: trivalent (CrIII) and hexavalent (CrVI). Acute exposure to chromium can result in kidney damage following oral exposure, or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (Gradient, 1991). Oral RfD values for both forms of chromium are 1.0 and 5E-3 (mg/kg-day), respectively. For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered as a group A carcinogen for inhalation exposures, and a SF_0 of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for chromium (III). The uncertainty factor was determined to be 100 and the modifying factor was determined to be 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor was 500 and the modifying factor was 1.

Manganese is an essential nutrient. Chronic exposure to manganese, 0.8 mg/kg-day, causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese from food, and the elderly appear to be more sensitive than children (Klaassen et al., 1986; Dreisbach et al., 1987). Because of the different uptake rates in water and food, USEPA set two oral RfDs. These RfDs are 0.005 mg/kg-day and 0.14 mg/kg-day for food. Inhaling manganese dust causes neurological effects and increased incidence of pneumonia; an inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS (search date 6/29/95), the classification is based on studies that are inadequate to assess manganese's carcinogenicity. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was determined to be 1 and the modifying factor was determined to be 1. The critical effects of this chemical in food in the oral summary are CNS effects. The uncertainty factor was determined to be 1 and the modifying factor was determined to be 1. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. The uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

PCB Aroclors are a group of chlorinated hydrocarbons (such as ***Aroclors-1248, 1254, and 1260***) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme concentrations, rashes, chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified PCB Aroclors as group B2 carcinogens, primarily based on animal data. As listed in IRIS (search date 6/29/95), the classification is based on hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate, yet suggestive, evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. USEPA set 7.7 (mg/kg-day)$^{-1}$ as the SF_o for PCB Aroclors, and the RfD was set to 0.00007 mg/kg-day.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene (BAP), having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEF, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the Exposure and Toxicity Assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soots, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the BAP B2 classification is based on insufficient human data specifically linking it to a carcinogenic effect. There are, however, multiple animal studies in many species demonstrating BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 Carcenogen Risk Assessment Verification Endeavor (CRAVE) Work Group meeting, a revised risk estimate for BAP was verified. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and are presented as the risk per (mg/kg-day). The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the RfD_o and RfC sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is based on no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the benzo(a)anthracene B2 classification is based on no human data but sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the benzo(k)fluoranthene B2 classification is based on no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene***. USEPA determined RfDs for only two of these compounds. Pyrene's RfD_o is 0.03 mg/kg-day, and this RfD is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

Dioxins are chlorinated hydrocarbons which accumulate in fat tissue. Exposure to dioxins, known to be potent mutagens and teratogens, causes burning pain in the tongue, abdomen, and pharynx, along with chloracne, loss of body weight, degenerative changes to the liver and thymus, and psychiatric disturbances. Chloracne is the primary sign of human exposure (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified dioxins as group B2 carcinogens and determined the SF_o to be 150,000 $(mg/kg\text{-}day)^{-1}$ for 2,3,7,8-TCDD. Equivalent concentrations of other dioxin congeners were calculated based on their corresponding toxic equivalents, as recommended by USEPA.

1,4-Dichlorobenzene is a CLP SVOC; however, it was evaluated for the inhalation pathway as a volatile due to its Henry's law constant. This compound affects the CNS, causes liver and kidney damage, and irritates mucous membranes, skin, and eyes (Dreisbach et al., 1987). This compound is classified by USEPA as a B2 carcinogen with an SF_o of 0.024 $(mg/kg\text{-}day)^{-1}$. The RfD_i was set to 0.229 mg/kg-day. As listed in IRIS (search date 6/29/95), the critical effect of this chemical is increased liver weights in P1 males. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfC is 0.8 mg/m^3.

Ethylbenzene is used as a solvent. Chronic exposure to ethylbenzene can cause dizziness, weight loss, weakness, and/or numbness in the limbs, anemia, and nervousness; the target organ is the CNS (Dreisbach et al., 1987). As listed in IRIS (search date 6/29/95), the D classification is based on a lack of animal bioassays and human studies. This compound is a volatile organic, and USEPA determined the RfD_o to be 0.1 mg/kg-day. The RfD_i was set to 0.286 mg/kg-day. As listed in IRIS (search date 6/28/95), the critical effect of this chemical is liver and kidney toxicity. The uncertainty factor was 1,000 and the modifying factor was 1.

Chlorobenzene, a volatile organic that affects the CNS, causes liver and kidney damage and irritates of the mucous membranes, skin, and eyes (Dreisbach et al., 1987). As listed in IRIS (search date 6/28/95), the D classification is based on no human data, inadequate animal data, and predominantly negative genetic toxicity data in bacterial, yeast, and mouse lymphoma cells. USEPA set the RfD_o and RfD_i to 0.02 and 0.00571 mg/kg-day, respectively. As listed in IRIS, the critical effect of this chemical is histopathologic changes in liver. The uncertainty factor was 1,000 and the modifying factor was 1.

1,2-Dichloroethane is used as a solvent in the rubber, plastic, and insecticide industries. This compound is also used as a gasoline additive and is used in some rubber and plastic cements used in various hobbies. Municipal water supplies commonly detect dichloroethane as a contaminant if the municipal water treatment facility uses chlorine in its water-cleaning processes. Detected concentrations range from 0.2 to 6 μg/L (Klaassen, et al., 1986), and the MCL is 5 μg/L . The fatal adult dose is approximately 5 ml of 1,2-dichloroethane, and the time-weighted average exposure limit is 1 ppm for inhalation exposure. The inhalation exposure limit is below the odor threshold, 3 ppm.

Fatty liver, liver cell damage, and kidney damage are the primary noncancer toxic effects caused by dichloroethane. Because this compound is chemically transformed into a toxic metabolite by enzymes in the liver (biotransformation), toxic effects can be greatly enhanced (synergism) when the liver's enzymes are induced. Enzyme inducers such as ketones and alcohols can lead to synergistic toxic effects. An additional, secondary effect evident in canine studies is the clouding of corneal eye tissue. This effect was indirect, apparently occurring following biotransformation by liver enzymes, and was not caused by direct eye exposure to dichloroethane. Based on Region III's RBC Table (March 1995), USEPA determined the inhalation reference dose to be 0.00286 mg/kg-day. No reference dose is currently available for the ingestion exposure pathway.

This compound can react with DNA, which indicates a potential to cause cancer. Studies indicate this compound is a carcinogen if ingested (Klaassen et al), but the reference data do not indicate inhaling this compound would cause cancer. USEPA has classified dichloroethane as a B2 carcinogen and determined the slope factor to be 0.091 $(mg/kg\text{-}day)^{-1}$ for both ingestion and inhalation exposure. As listed in IRIS (search date 6/29/95), the classification is based on the induction of several tumor types in rats and mice treated by gavage, and lung papillomas in mice after topical application.

1,1-Dichloroethene is a VOC primarily toxic to the liver, CNS, and kidneys. The mucous membrane, skin, lung, and cornea (irritation) are also affected. 1,1-Dichloroethene is more toxic than 1,2-Dichloroethene (Dreisbach et al., 1987). This chlorinated compound is a USEPA group C carcinogen. The RfD_o is 0.009 mg/kg-day, and the SF_o and SF_i are 0.6 and 0.175 $(mg/kg\text{-}day)^{-1}$, respectively.

Hexachloroethane, a VOC, has been shown to have toxic effects on the CNS, the liver, and the kidneys (Dreisbach et al., 1987). USEPA determined the RfD_o to be 0.001 mg/kg-day. USEPA determined the SF_o and SF_i to be 0.014 $(mg/kg\text{-}day)^{-1}$.

Hexachlorobutadiene, a VOC, has been shown to elicit toxic effects on the CNS, the liver, and the kidneys (Dreisbach et al., 1987). USEPA determined the RfD_o to be 0.0002 mg/kg-day. USEPA determined the SF_o and SF_i to be 0.078 and 0.077 $(mg/kg\text{-}day)^{-1}$, respectively.

Azobenzene, a VOC, is a carcinogen that can damage the liver and kidney. As listed in IRIS (search date 6/29/95), the B2 classification is based on azobenzene induced invasive sarcomas in the spleen and other abdominal organs in male and female F344 rats following dietary administration. It is genotoxic and may be converted to benzidine, a known human carcinogen, under the acidic conditions in the stomach (Dreisbach et al., 1987). USEPA determined the SF_o to be 0.11 $(mg/kg\text{-}day)^{-1}$, an RfD_o has not been determined.

Benzidine is a Class A carcinogen. This compound can cause bladder irritation and is a sensitizer. As listed in IRIS (search date 6/28/95), the classification is based on increased incidence of bladder cancer and bladder cancer-related deaths in exposed workers (Dreisbach et al., 1987). The SF_o for benzidine is 230 $(mg/kg\text{-}day)^{-1}$, and the RfD_o is 0.003 mg/kg-day. As listed in IRIS, the critical effect of this chemical is brain cell vacuolization and liver cell alteration in females. The uncertainty factor was 1,000 and the modifying factor was 1.

Chloroform, a halogenated hydrocarbon, has been used as a fumigant and an additive used to suppress the fire hazard of carbon disulfide, as well as having a low capacity for insect control. Volatile and gaseous anesthetics such as chloroform are sometimes used to produce general anesthesia. This contaminant is the primary chlorinated hydrocarbon produced during chlorination of drinking water, and is commonly present at low concentrations in most public drinking water supplies. This compound depresses all CNS function in descending order from the cortex to the medulla. Additional target organs include the liver, heart, and kidney. Exposure of the heart to chloroform sensitizes the muscle to arrhythmias, as does exposure to many halogenated hydrocarbons. This action could interfere with digitalis glycosides or a pacemaker in the form of premature or uncontrolled beats (Dreisbach et al., 1987). Chloroform is a class B2 carcinogen, and USEPA set the SF_o and SF_i to 0.0061 and 0.0805 $(mg/kg\text{-}day)^{-1}$, respectively. As listed in IRIS (search date 11/22/95), the classification is based on increased incidence of several tumor types in rats and three strains of mice. The RfD_o is 0.01 mg/kg-day. As listed in IRIS, the critical effect of this chemical is fatty cysts formation in liver. The uncertainty factor was 1,000 and the modifying factor was 1.

2,4-Dimethylphenol and most compounds related to phenol are cellular toxicants. These compounds can cause bladder tumors, and might be carcinogens and/or sensitizers. USEPA has determined the RfD_o to be 0.02 mg/kg-day (Dreisbach et al., 1987). As listed in IRIS (search date 6/29/95), the critical effect of this chemical is clinical signs (lethargy, prostration, and ataxia) and hematological changes. The uncertainty factor was 3,000 and the modifying factor was 1.

2-Methylphenol and most compounds related to phenol are cellular toxicants. These compounds can cause bladder tumors, and might be carcinogens and/or sensitizers. As listed in IRIS (search date 11/22/95), the classification is based on increased incidence of skin papillomas in mice in an initiation-promotion study. The three cresol isomers produced positive results in genetic toxicity studies both alone and in combination. USEPA has determined the RfD_o to be

0.05 mg/kg-day. As listed in IRIS, the critical effect is decreased body weights and neurotoxicity. The uncertainty factor was 1,000 and the modifying factor was 1.

4-Methylphenol and most compounds related to phenol are cellular toxicants. These compounds can cause bladder tumors, and might be carcinogens and/or sensitizers (Dreisbach et al., 1987). USEPA has determined the RfD_o to be 0.005 mg/kg-day.

Pentachlorophenol and most compounds related to phenol are cellular toxicants. These compounds can cause bladder tumors, and might be carcinogens and/or sensitizers (Dreisbach et al., 1987). USEPA has determined the RfD_o to be 0.03 mg/kg-day and the SF_o to be 0.12 $(mg/kg\text{-}day)^{-1}$, respectively.

Hexachlorocyclopentadiene is a volatile organic that is a general irritant, a USEPA class B2 carcinogen, toxic to the liver and kidneys, and can affect the CNS (Dreisbach et al., 1987). USEPA determined the RfD_o to be 0.01 mg/kg-day. The oral SF was determined to be 0.0061 $(mg/kg\text{-}day)^{-1}$ and the inhalation SF was determined to be 0.0805 $(mg/kg\text{-}day)^{-1}$.

Trichloroethene (TCE) is a mobile, volatile liquid with has the characteristic odor of chloroform. Inhalation, intravenous, and subcutaneous routes are all viable exposure pathways for this compound. TCE is a strong skin and eye irritant that is relatively less toxic if ingested. Inhalation of high concentrations causes narcosis and anesthesia. This compound targets the liver and other organs (Dreisbach et al., 1987). TCE is a B2 carcinogen, and the SF_o and SF_i have been set by USEPA to 0.011 and 0.006 $(mg/kg\text{-}day)^{-1}$, respectively. As listed in IRIS (search date 11/22/95), the carcinogen assessment summary for this substance has been withdrawn following further review. A new carcinogen summary is in preparation by the CRAVE Work Group. USEPA also set the RfD_o to 0.006 mg/kg-day.

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract, which is the target. Another target is the blood, where antimony concentrates. Due to frequent industrial use, the primary exposure route for antimony to the general population is food. Antimony is also a common air pollutant from industrial emissions (Klaassen et al., 1986). USEPA has not classified antimony as a carcinogen, and the RfD_o is 0.0004 mg/kg-day. As listed in IRIS (search date 6/28/95), the critical effect of this chemical is longevity, blood glucose, and cholesterol. The uncertainty factor was determined to be 1,000 and the modifying factor was determined to be 1.

Barium is used in various alloys, paints, soap, and manufacture processes. Barium sulfate aids X-ray diagnosis. This element is relatively abundant in nature and is found in plant and animal tissue. Brazil nuts contain 3 to 4 mg per gram nuts. The fatal absorbed dose of barium is approximately 1,000 mg (for humans). Assuming an absorption efficiency of 5% for barium, 20,000 mg ingested barium could be fatal (approximately 333 Brazil nuts, assuming 15 g/nut). Major toxic effects of this element are muscle stimulation, CNS effects, and effects on the heart (Dreisbach et al., 1987; Klaassen et al., 1986). USEPA determined the RfD_o and RfD_i to be 0.07 and 1.43E-4 mg/kg-day, respectively. As listed in IRIS (search date 6/29/95), the critical effect of this chemical is increased blood pressure. The uncertainty factor was 3 and the modifying factor was 1.

Nickel is also an essential nutrient; a 5 microgram dose is typical of supplemental vitamins. USEPA set the RfD_o to 0.02 mg/kg-day. Chronic exposure of rats to nickel caused decreased body and organ weights. For a chronically exposed individual, nickel salts would affect the gastrointestinal system, and would also target the liver and kidney. This element has been shown to produce allergic reactions. Sensitization of skin to nickel dust has been shown to occur in industry (Dreisbach, et al., 1987). As listed in IRIS (search date 6/28/95), the critical effect of this chemical is decreased body and organ weights. The uncertainty factor was 300 and the modifying factor was 1.

bis(2-Chloroethyl)ether is a carcinogen affecting the liver. Its primary noncarcinogenic targets would be the liver and kidney, based on the structural similarity to bis(2-chloromethyl)ether. USEPA set the SF_i and SF_o to 1.16 and 1.10 $(mg/kg\text{-}day)^{-1}$, respectively. These values were obtained from the RBC Table (USEPA Region III, 1995). As listed in IRIS (search date 6/29/95), the B2 classification is based on positive carcinogenicity results in two strains of mice and evidence of mutagenicity.

bis(2-Ethylhexyl)phthalate, otherwise known as BEHP, is a plasticizer used in virtually every major product category. Phthalate esters are ubiquitously distributed in the environment. Although the toxicity of this compound is relatively low, it is a carcinogen. Reproductive effects are also possible (indicated in animal studies) due to chronic exposure to BEHP (Klaassen et al., 1986). As listed in IRIS (search date 10/17/95), the classification is based on orally administered BEHP producing significant dose-related increases in liver tumor responses in rats and mice of both sexes. This compound is classified as a B2 carcinogen, and USEPA set the RfD_o and SF_o to 0.02 mg/kg-day and 0.014 $(mg/kg\text{-}day)^{-1}$, respectively. As listed in IRIS, the critical effect of this chemical is increased relative liver weight. The uncertainty factor was 1,000 and the modifying factor was 1.

Copper is a nutritionally essential element, necessary for many of the body's enzymes. Copper has been used to replace lead water pipes in residences due to its lower toxicity to man. Short-term exposure to copper can result in anemia (the lack of iron), the breakdown of red blood cells, and liver and kidney lesions. The target organs for copper are the liver, kidney, and red blood cell. Vitamin C reduces copper uptake from the gut, and other substances can also influence copper uptake. Copper fumes can cause metal fume fever (Klaassen et al., 1986). As listed in IRIS (search date 6/28/95), the D classification is based on no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data. The RfD set by the USEPA is 0.0371 mg/kg-day, which is 2.6 mg/day for the average adult (70 kg). In typical vitamin supplements, 2 mg/day is the approximate dose (NRC, 1989).

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used as a rodenticide and ant killer, now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA's RfD_o for thallium is 0.00008 mg/kg-day.

Zinc is an essential, ubiquitous element present in food, water, and soil. The average American daily intake is approximately 12 to 15 mg, and the recommended daily allowance (RDA) is 15 mg. Excessive exposure to zinc is relatively uncommon and requires exposure to high concentrations. This element does not accumulate under chronic exposure conditions, and body content is self-regulated by zinc liver levels and absorption mechanisms. Inhalation of zinc dust can cause metal fume fever, and the primary effect of zinc ingestion (at toxic concentrations) is gastrointestinal disturbance and irritation. Other effects on the blood, liver, and kidney are possible at higher concentrations. Twelve grams of elemental zinc per day were not shown to elicit effects other than gastrointestinal disturbances over a two-day period. Experimental animals have been given 100 times the dietary requirements without discernible effects (Klaassen et al., 1986). As listed in IRIS (search date 6/28/95), D classification is based on inadequate evidence in humans and animals. USEPA determined that the RfD_o is 0.3 mg/kg-day. As listed in IRIS, the critical effect of this chemical is a 47% decrease in erythrocyte superoxide dismutase (ESOD) concentration in adult females after 10 weeks of zinc exposure.

Carbon disulfide is a VOC that affects the nervous system. At toxic levels, nervous system effects (in humans) include psychosis, tremor, and weakness in the lower extremities. This compound interferes with the conduction of nerve signals to produce these effects. Carbon disulfide has been associated with reproductive dysfunction in men and women. In addition, at doses well within what was thought to be safe for industry in Japan, some effects on the eye have been produced, and similar effects were observed in Finland (Klaassen et al., 1986).

USEPA set the RfD_o and RfD_i to 0.1 and 0.00286 mg/kg-day, respectively. As listed in IRIS (search date 6/28/95), the critical effect of this chemical is fetal toxicity/malformations. The uncertainty factor was 100 and the modifying factor was 1.

6.2.1.5 Risk Characterization

Surface Soil Pathway

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants, evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 6.2.1.43 through 6.2.1.54 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with surface soil at each site within SWMU 9. COCs identified in soil are identified and briefly discussed at the end of each AOC/SWMU presentation. Detailed discussions and a tabular summary of COCs identified at SWMU 9 are presented in the COCs Identification Section.

SWMU 19

Hypothetical Site Residents

Tables 6.2.1.43 and 6.2.1.44 present the ingestion and dermal risk/hazard estimates for SWMU 19. The ingestion ILCR (based on the adult and child lifetime weighted average) for SWMU 19 surface soil is 6E-5. Arsenic is the primary contributor to ILCR with an ingestion ILCR of 3.7E-5. Other contributors to ILCR are BEQs, Aroclor-1254, Aroclor-1260, and beryllium. Arsenic contributes approximately five times the risk of any other COPC. The dermal pathway ILCR is 9E-6, with arsenic again contributing the greatest amount.

The computed HI for the adult resident ingestion pathway was estimated to be 0.3. The HI for the child was estimated to be 3 for the ingestion pathway. The dermal contact pathway HIs for the adult and child residents were estimated to be 0.07 and 0.2, respectively. Arsenic was the primary contributor to the HI.

COCs identified for this scenario based on their contribution to risk/hazard are: Aroclor-1254, Aroclor-1260, antimony, arsenic, BEQs, beryllium, copper, nickel, and zinc.

Hypothetical Site Workers

Site worker ILCRs are 6E-6 and 4E-6 for the ingestion and dermal contact pathways, respectively. The HIs for the ingestion and dermal pathways are 0.1 and 0.05, respectively, for the hypothetical site worker.

COCs identified for this scenario based on their contribution to risk/hazard are Aroclor-1260, BEQs, arsenic, and beryllium.

PCB Aroclor-1254 was reported in only one of 18 surface soil samples (019SB007), while PCB Aroclor-1260 was reported in eight of 18 locations. PCBs reported in SWMU 19 soil do not define a hot spot, but were generally reported at locations other than the most northeastern sample locations. Arsenic was reported in 14 of 18 samples, beryllium was reported in 15 of 18 samples, and BEQs were reported in 15 of 18. All arsenic and beryllium concentrations reported exceeded the corresponding RBC. Ten of 18 benzo(a)pyrene equivalent concentrations exceed the corresponding RBC, and again, no definable hot spot was identified. Nickel and zinc exceed their RBCs at only one sample location, 019SB004, and antimony exceeds the RBC at location 019SB002. Three arsenic hits exceeded the UTL, as did one beryllium hit.

SWMU 19 Lead Toxicity

Background

Currently, USEPA has established neither an SF nor an RfD for lead. USEPA believes that the available studies in animals and humans do not provide sufficient quantitative information for their calculation. Although lead is currently classified as a B2 carcinogen, the USEPA considers the noncarcinogenic neurotoxic effects in children to be the critical toxic effect with respect to establishing health-based environmental cleanup objectives. The neurotoxic effects of chronic low-level lead exposure in children may occur at blood concentrations levels as low as 10 μg/dL.

In the absence of lead health criteria, USEPA Region IV's Office of Health Assessment sanctions the use of the Lead Uptake/Biokinetics Model (Version 0.99d) (Lead Model) to predict mean blood lead levels in children based on exposure to impacted environmental media. This model was used to assess the potential health effects of elevated lead reported in surface soil at SWMU 19. The maximum lead concentration reported in surface soil was 6,170 mg/kg at location 019SB017.

Lead Uptake/Biokinetics Model

Blood lead levels in the age group 0 to 7 can be predicted using the Lead Model. Such estimates can assist in risk management decisions regarding cleanup of lead at hazardous waste sites. The effects of lead exposure are complex, and the assumptions used in the Lead Model are continually updated to reflect recent research findings. The results presented are hypothetical estimates since many of the model assumptions are subject to change.

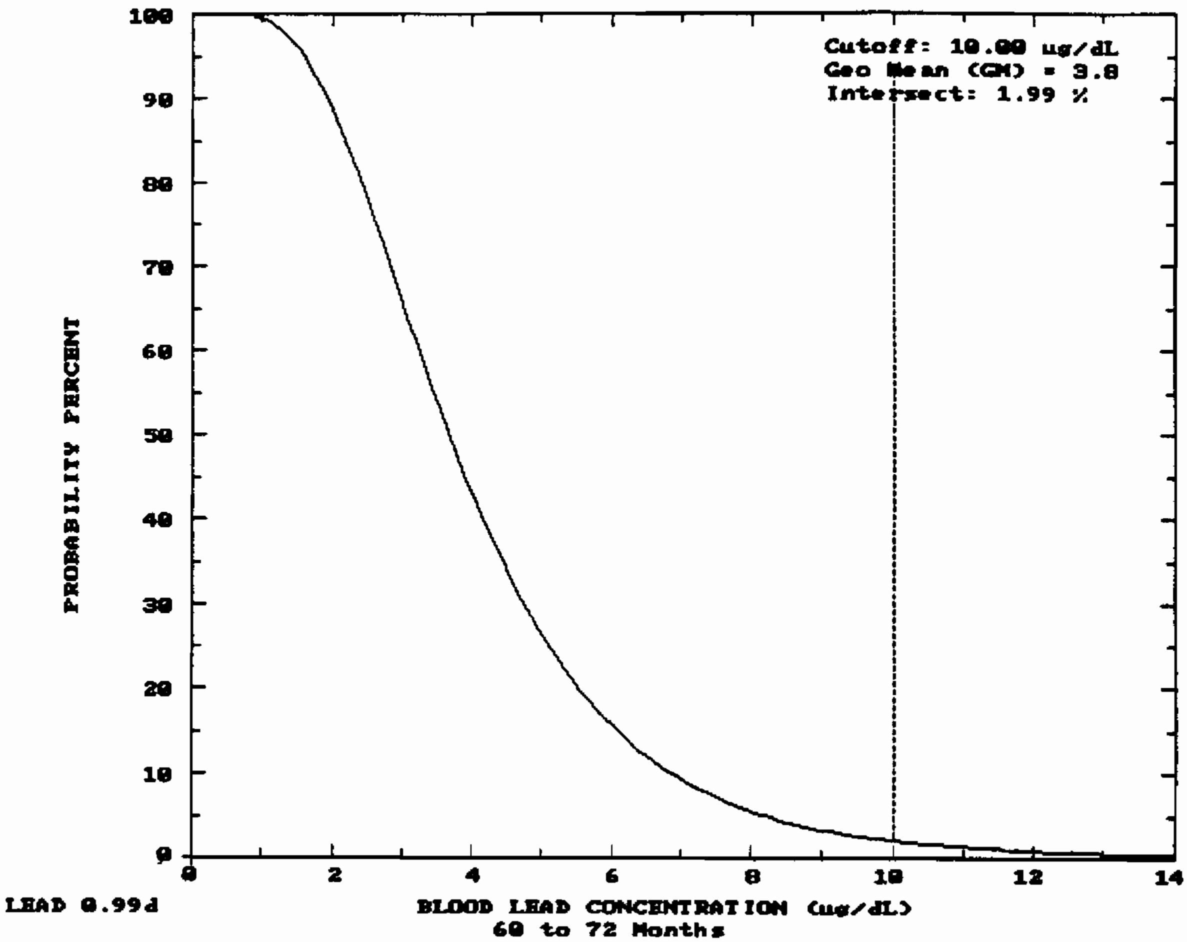
In coordination with USEPA Region IV's Office of Health Assessment, a conservative exposure scenario was developed to assess the significance of surface soil lead concentrations at SWMU 19. This scenario involves a child (age 5 to 6) who gains access to the most heavily contaminated area for one day, and is maximally exposed. The scenario was developed based on the proposed future use of the SWMU 9 area which includes SWMU 19. Current base reuse plans indicate that the area will become a marine industrial park, intermodal railyard, and associated open buffer space. The exposure frequency was based on the child accompanying a parent to work at a nearby building on a one-time basis and wandering into SWMU 19 over the course of that day.

The assumption was made that this child would ingest 0.1 grams of soil from the most heavily contaminated area. In the case of SWMU 19, the lead hot spot was identified as boring location 019SB017, and the three closest sampling locations surrounding this point (locations 019SB004, 019SB006, and 019SB007). The total area encompassed by these locations is 0.25-acre, and the mean surface soil lead concentration is 1,825 mg/kg. Within the Lead Model, an alternate source was entered to account for this exposure, as previously discussed. The bioavailability of lead ingested from the alternate source (SWMU 19 surface soil) was set equal to that of soil lead ingested from the standard residential default source. Assuming a one-time exposure in the most heavily impacted area, the annualized alternate source exposure was estimated to be 0.5 μg lead/day. Table 6.2.1.45 presents the Lead Model output for a child 5 to 6 years of age under these exposure conditions.

Child exposure is presented as a reasonable worst-case scenario for exposure to lead concentrations in SWMU 19 soil. The most likely receptors, considering the proposed industrial use of the SWMU 19 area, are adults rather than children. USEPA Region IV has calculated a soil cleanup/screening level for lead of 1,300 mg/kg based on adult exposures. The mean surface soil concentration for SWMU 19 (576 mg/kg) falls below the USEPA adult cleanup/screening level.

Figure 6.2.1.1 shows the probability percentage of blood levels for the hypothetical child receptor. Based on this model output, the geometric mean blood level is estimated to be 3.8 μg/dL, and the probability of blood lead levels in excess of 10 μg/dL is 1.99%. USEPA

Figure 6.2.1.1
SWMU 19 Lead Uptake/Biokinetic Model Output
Child Blood Lead Level Probability Percentage



Note: The probability percentage plot was provided as output from the USEPA Lead Uptake/Biokinetic Model (Version 0.99d) performed for SWMU 19. The exposure assumptions used within the Lead Model are described in accompanying text.

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generally considers media concentrations that result in probability percentage estimates of 5% or less sufficiently protective of potential child receptors. As a result, surface soil lead concentrations at SWMU 19 would not require specific action under this hypothetical exposure scenario.

SWMU 20

Hypothetical Site Residents

Tables 6.2.1.46 and 6.2.1.47 present the ingestion and dermal contact risk/hazard estimates for SMWU 20. The ingestion ILCR (based on the adult and child lifetime weighted average) for SWMU 20 surface soil is 9E-6. The benzo(a)pyrene equivalent concentration is the only contributor to ILCR with an ingestion ILCR of 9.4E-6. The dermal pathway ILCR is 4E-6. No reference dose was available from the available literature for BEQs. Therefore, no hazard index was computed for these COPCs.

The COCs identified for this scenario based on contribution to risk are BEQs.

Hypothetical Site Workers

Site worker ILCRs are 1E-6 and 2E-6 for the ingestion and dermal contact pathways, respectively. No reference dose was available from the available literature for BEQs. Therefore, HI were not computed for these COPCs.

The COCs identified for this scenario based on contribution to risk are BEQs. BEQs concentrations were reported in 10 of 11 surface soil samples at SMWU 020 at concentrations exceeding the corresponding RBC.

SWMU 121

Hypothetical Site Residents

Tables 6.2.1.48 and 6.2.1.49 present the ingestion and dermal contact risk/hazard estimates for SWMU 121. The ingestion ILCR (based on the adult and child lifetime weighted average) for SWMU 121 surface soil is 1E-4. Beryllium, arsenic, Aroclor-1254, and BEQs are the primary contributors to ILCR, having individual ILCRs of 4.9E-5, 3.0E-5, 2.5E-5, and 1.5E-5, respectively. The dermal pathway ILCR was estimated to be 3E-5, with Aroclor-1254 as the largest contributor. Secondary contributors are BEQs, beryllium, Aroclor-1260, and arsenic.

The computed HI for the adult resident ingestion pathway was estimated to be 0.6. The child HI of 5 for the ingestion pathway was primarily due to the HQs for copper (1.4) and Aroclor-1254 (1.3). Secondary contributors are arsenic, nickel, vanadium, and zinc. The dermal contact pathway HIs for the adult resident and the child scenario were estimated to be 0.2 and 0.7, respectively.

COCs identified for this scenario are: antimony, Aroclor-1248, Aroclor-1254, Aroclor-1260, arsenic, BEQs, beryllium, copper, mercury, nickel, thallium, vanadium, and zinc.

Hypothetical Site Workers

Site worker ILCRs for SWMU 121 soil are 1E-5 for both the dermal contact and ingestion pathways, primarily due to the contributions of arsenic, beryllium, BEQs, and Aroclor-1254. The HIs for the ingestion and dermal pathways were estimated to be 0.2 and 0.1, respectively, for the hypothetical site worker. COCs identified for this scenario are: Aroclor-1254, Aroclor-1260, arsenic, BEQs, and beryllium.

Many COCs were detected across the site. However, concentrations exceeding corresponding RBCs were generally reported more frequently toward the center. Antimony was detected in four of 17 samples at locations 121SB002 through 121SB005. The concentrations reported at

121SB003 and 121SB005 exceeded the corresponding RBC. However, none of the antimony concentrations reported at SWMU 121 would result in a HQ exceeding 1.0.

Aroclor-1254 was reported in eight of 17 and Aroclor-1260 was reported in 12 of 17 total samples. PCBs were reported at all surface soil sample locations other than two near the southern end of SWMU 121 — samples 121B005 and 121SB013.

Beryllium and BEQs were detected across SWMU 121. Reported concentrations of each COC exceeded the corresponding RBC at all SWMU 121 sample locations. BEQs were reported in 11 of 16 samples. Arsenic was reported in 11 of 17 surface soil samples, with the reported concentrations exceeding the corresponding RBC at sample locations 121SB001 through 121SB011. Except for thallium, the other inorganic COCs were reported in 85% or more of surface soil samples. Thallium was reported in only one sample, 121SB001. Nickel, mercury, vanadium, copper, and zinc were reported at concentrations exceeding their corresponding RBCs in eight of 17, two of 17, seven of 17, 12 of 17, and seven of 17 samples, respectively. The number of exceedances per sample location was generally concentrated in the center of SWMU 121. Comparisons to UTLs identified concentrations exceeding UTLs for arsenic (one of 11), beryllium (nine of 16), chromium (one of 16), copper (all 16), lead (13 of 16), manganese (one of 16), mercury (nine of 16), nickel (13 of 16), thallium (one of 16), vanadium (five of 16), and zinc (15 of 16). The distribution of mercury, nickel, thallium, vanadium, copper, and zinc roughly defines an area comprising approximately 50% of SWMU 121. The FI/FC multiplier was not applied. If it were, the risk/hazard for these COCs would be reduced by 50% of the risk and hazard estimates shown in Tables 6.2.1.48 through 6.2.1.50.

Mercury and nickel should not be considered COCs based on the FI/FC. Their contribution to the HI would be reduced to below 0.1, which would preclude mercury and nickel from being COCs.

SWMU 121 Lead Toxicity

Background

Currently, USEPA has established neither an SF nor an RfD for lead, as discussed earlier. USEPA believes that the available studies in animals and humans do not provide sufficient quantitative information for their calculation. Although lead is currently classified as a B2 carcinogen, USEPA considers the noncarcinogenic neurotoxic effects in children to be the critical toxic effect with respect to establishing health-based environmental cleanup objectives. The neurotoxic effects of chronic low-level lead exposure in children may occur at blood concentrations as low as 10 μg/dL.

In the absence of lead health criteria, USEPA Region IV's Office of Health Assessment sanctions the use of the Lead Model to predict mean blood lead concentrations in children based on exposure to impacted environmental media. This model was used to assess the potential health effects of elevated lead in surface soil at SWMU 121. The maximum lead concentration reported in surface soil was 2,770 mg/kg at location 121SB007.

Lead Uptake/Biokinetics Model

Blood lead levels in the age group 0 to 7 can be predicted using the Lead Model. Such estimates can assist in risk management decisions regarding cleanup of lead at hazardous waste sites. The effects of lead exposure are complex, and the assumptions used in the Lead Model are continually updated to reflect recent research findings. The results presented are hypothetical estimates since many of the model assumptions are subject to change.

In coordination with USEPA Region IV's Office of Health Assessment, a conservative exposure scenario was developed to assess the significance of surface soil lead concentrations at SWMU 121. This scenario involves a child (age 5 to 6) who gains access to the most heavily contaminated area for one day, and is maximally exposed. The scenario was developed based on the proposed use of the SWMU 9 area, which includes SWMU 121. Current base reuse plans indicate that the area will become a marine industrial park and intermodal railyard. The exposure frequency was based on the child accompanying a parent to work at a nearby building and wandering into SWMU 121 over the course of that day.

The assumption was made that this child would ingest 0.1 grams of soil from the most heavily contaminated area. In the case of SWMU 121, the maximum lead concentration was identified as boring location 121SB007. Half of the 16 surface soil samples collected exceeded the 400 mg/kg residential cleanup level. Based on the distribution of lead concentrations across the site, the UCL mean lead level (1,270 mg/kg) at SWMU 121 was used as the EPC. The total area of SWMU 121 is approximately 0.75 acre. Within the Lead Model, an alternate source was entered to account for this exposure as previously discussed. The bioavailability of lead ingested from the alternate source (SWMU 121 surface soil) was set equal to that of soil lead ingested from the standard residential default source. Assuming a one-time exposure is the most heavily impacted area, the annualized alternate source exposure was estimated to be 0.15 μg lead/day. Table 6.2.1.50 presents the Lead Model output for a child 5 to 6 years of age under these exposure conditions.

Child exposure is presented as a reasonable worst-case scenario for exposure to lead concentrations in SWMU 121 soil. The most likely receptors, considering the proposed industrial use of the SWMU 121 area, are adults rather than children. USEPA Region IV has calculated a soil cleanup/screening level for lead of 1,300 mg/kg based on adult exposures. The 95% UCL surface soil concentration for SWMU 121 (1,270 mg/kg) falls below the USEPA adult cleanup/screening level.

Figure 6.2.1.2 shows the probability percentage of blood levels for the hypothetical child receptor. Based on this model output, the geometric mean blood level is estimated to be 3.8 μg/dL, and the probability of blood lead levels in excess of 10 μg/dL is 1.99%. USEPA generally considers media concentrations that result in probability percentage estimates of 5% or less sufficiently protective of potential child receptors. As a result, surface soil lead concentrations at SWMU 121 would not require specific action under the hypothetical exposure scenario.

AOC 649 (includes AOC 651)

Hypothetical Site Residents

Tables 6.2.1.51 and 6.2.1.52 present the risk/hazard estimates for the ingestion and dermal contact estimates for AOC 649. The ingestion and dermal contact ILCR (based on the adult and child lifetime weighted average) for AOC 649 (which includes part of AOC 651) surface soil are 2E-6 and 1E-6, respectively. The only contributors to ILCR are BEQs. The computed HIs for the adult and child residential ingestion exposure pathway were estimated to be 0.03 and 0.3, respectively. The dermal contact pathway HIs for the adult resident and the child scenario were estimated to be 0.006 and 0.02, respectively. Mercury was the only contributor to the HIs.

The COCs identified for this scenario based on their contribution to risk/hazard are BEQs.

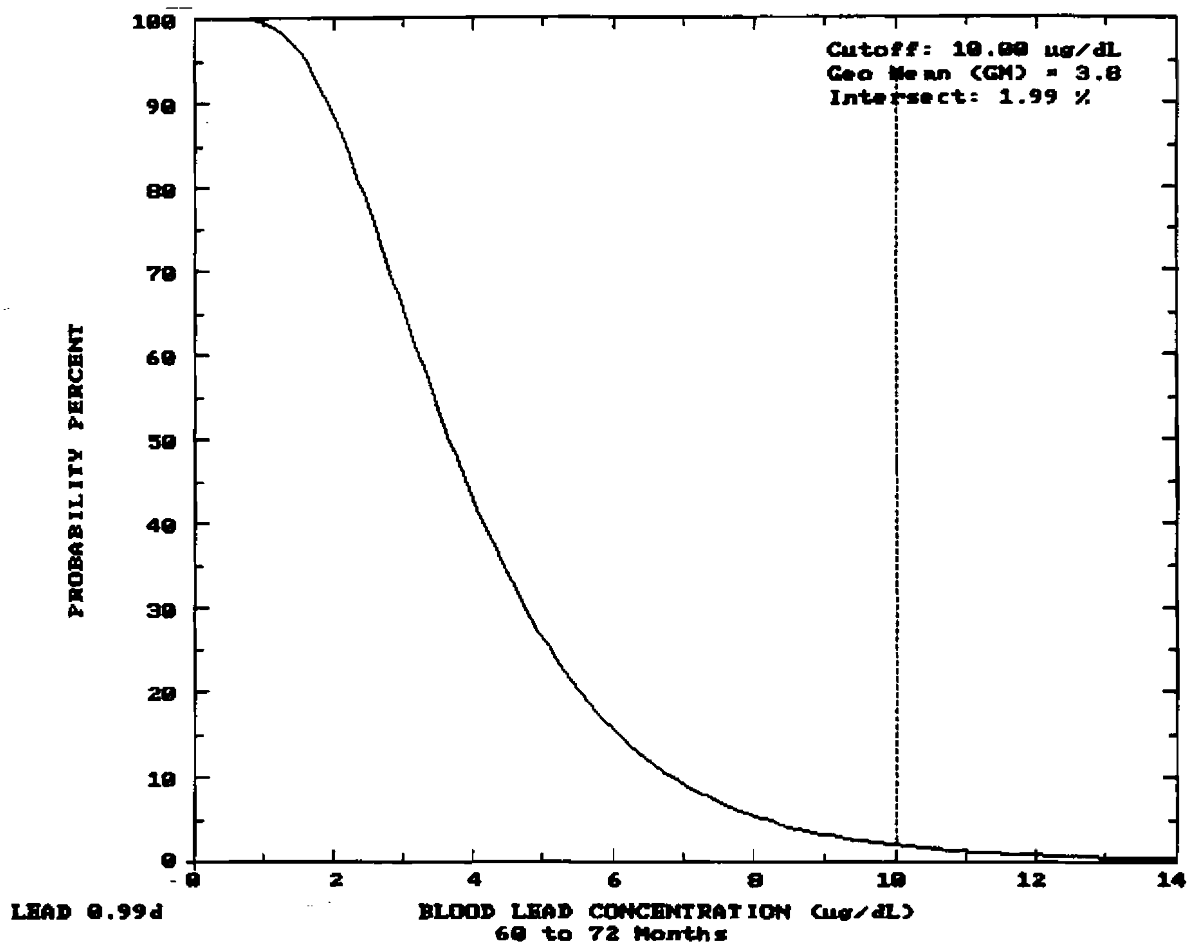
Hypothetical Site Workers

Site worker ILCRs are 3E-7 and 4E-7 for the ingestion and dermal contact pathways, respectively. The HIs for the ingestion and dermal pathways are 0.01 and 0.005, respectively, for the hypothetical site worker.

No COCs were identified for this exposure pathway.

At AOC 649, which includes part of AOC 651, BEQs were reported at five of 10 sample locations at concentrations exceeding the corresponding RBC. Mercury was reported at six of 10 sample locations, and exceeded the RBC at only one (649SB010).

Figure 6.2.1.2
SWMU 121 Lead Uptake/Biokinetic Model Output
Child Blood Lead Level Probability Percentage



Note: The probability percentage plot was provided as output from the USEPA Lead Uptake/Biokinetic Model (Version 0.99d) performed for SWMU 121. The exposure assumptions used within the Lead Model are described in accompanying text.

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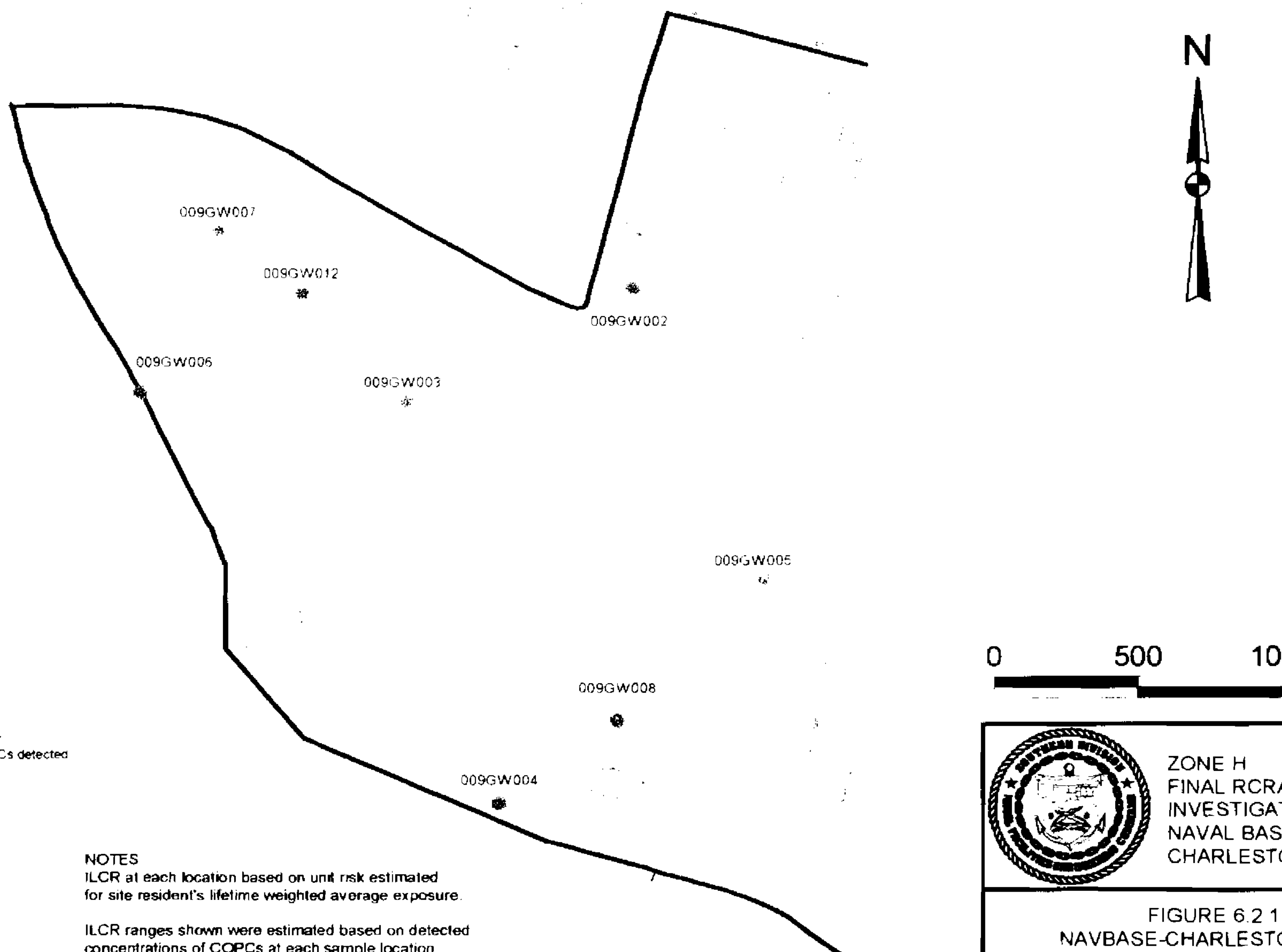

LEGEND

Round 2 Deep Groundwater
- No carcinogenic COPCs detected
- < 1E-6
- 1E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4
- Zone H Boundary
- Building
- Road
- Water
- Sidewalk
- Pier
- Fence

NOTES
ILCR at each location based on unit risk estimated
for site resident's lifetime weighted average exposure.

ILCR ranges shown were estimated based on detected
concentrations of COPCs at each sample location.

Concentrations reported for arsenic were below the MCL.
and arsenic was not included in the risk estimates for each location.

ZONE H
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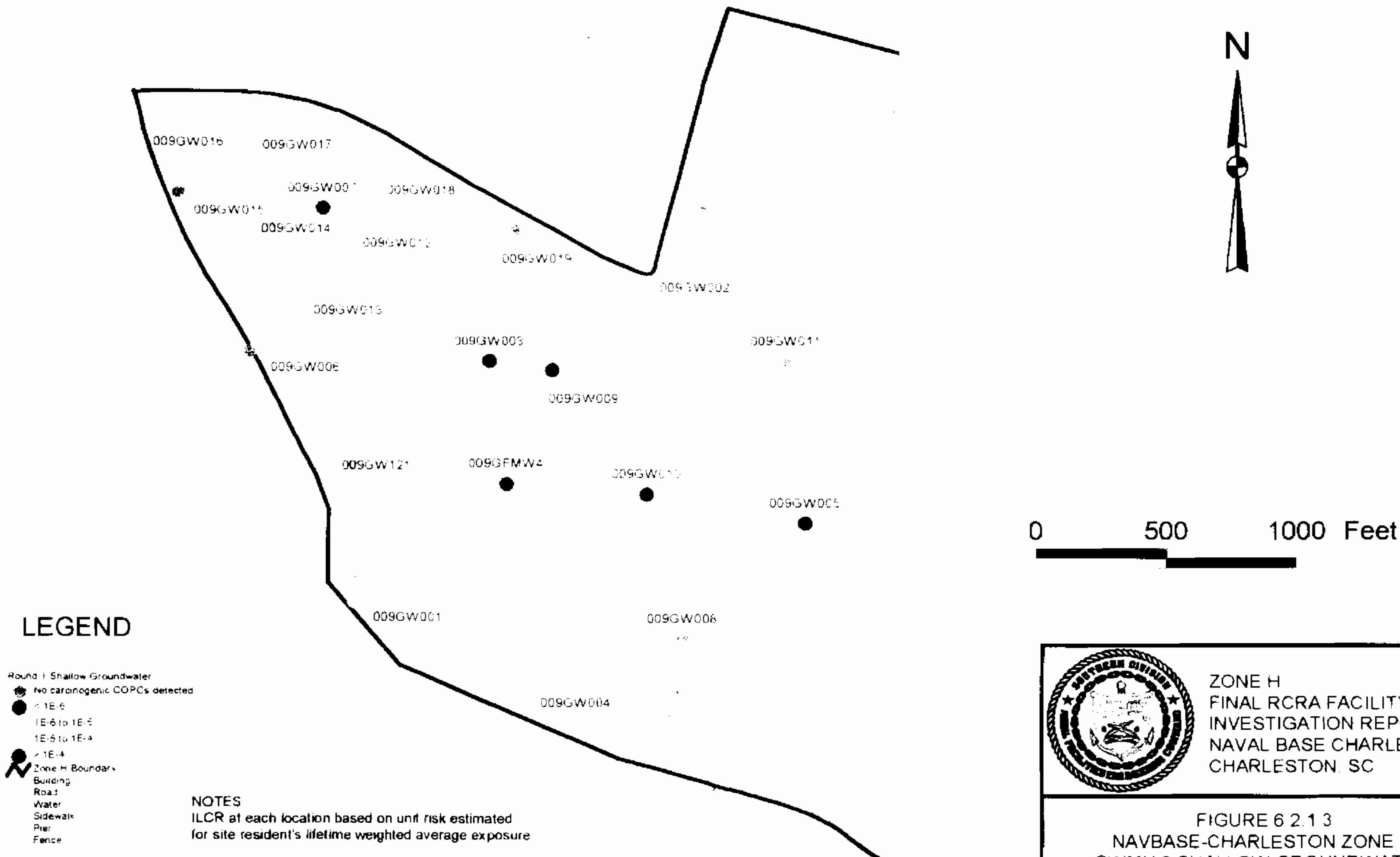
CHARLESTON, SC

FIGURE 6.2.1.10
NAVBASE-CHARLESTON ZONE H
SWMU 9 SHALLOW GROUNDWATER
2nd QUARTER
LOCATION SPECIFIC ILCR

DATE: 06/27/96	PROJ NAME: RFI009GW.APR



NOTES
ILCR at each location based on unit risk estimated for site resident's lifetime weighted average exposure

ILCR ranges shown were estimated based on detected concentrations of COPCs at each sample location.

ZONE H
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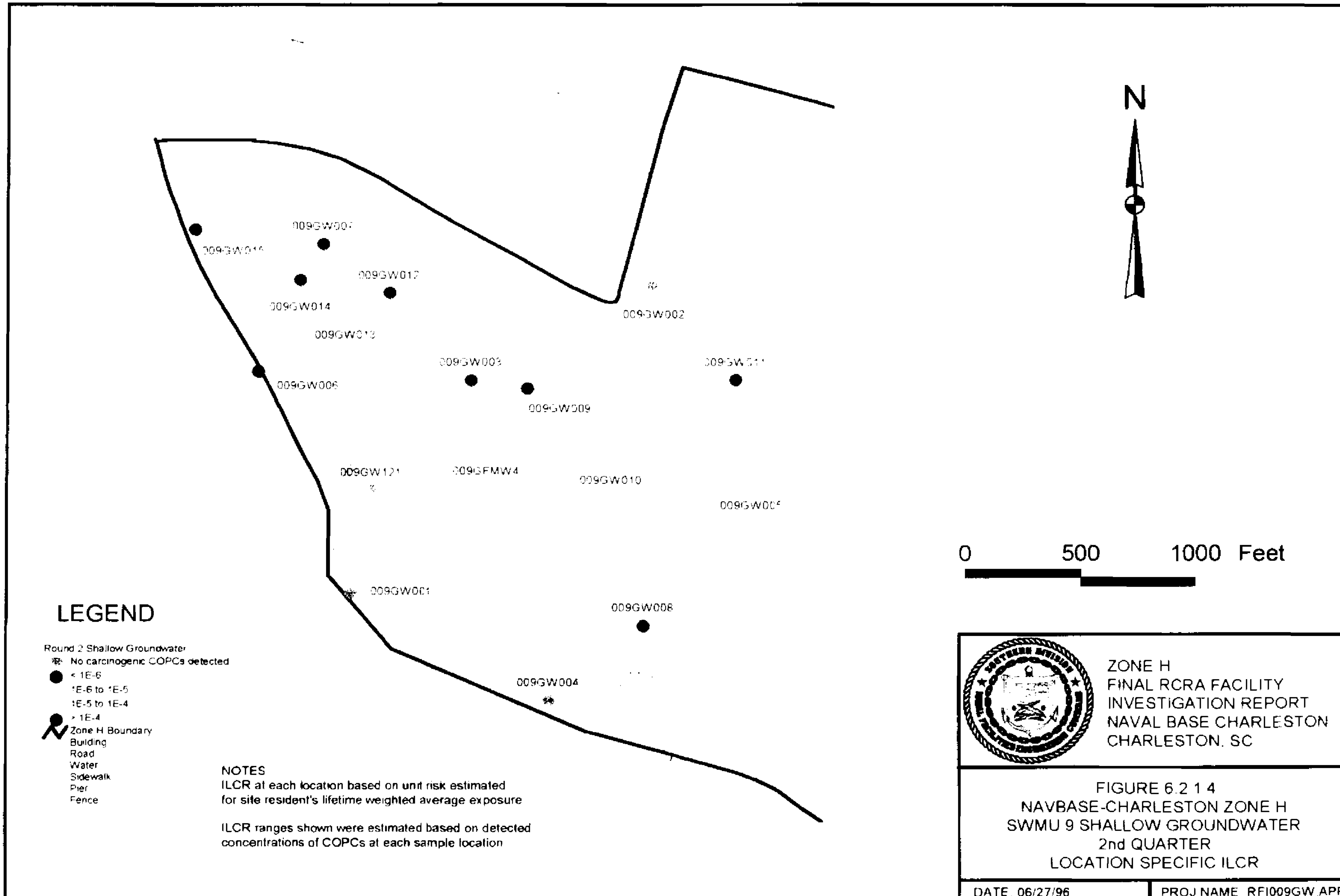
CHARLESTON, SC

FIGURE 6.2.1.3
NAVBASE-CHARLESTON ZONE H
SWMU 9 SHALLOW GROUNDWATER
1ST QUARTER
LOCATION SPECIFIC ILCR

DATE: 06/27/96	PROJ NAME: RFI009GW.APR



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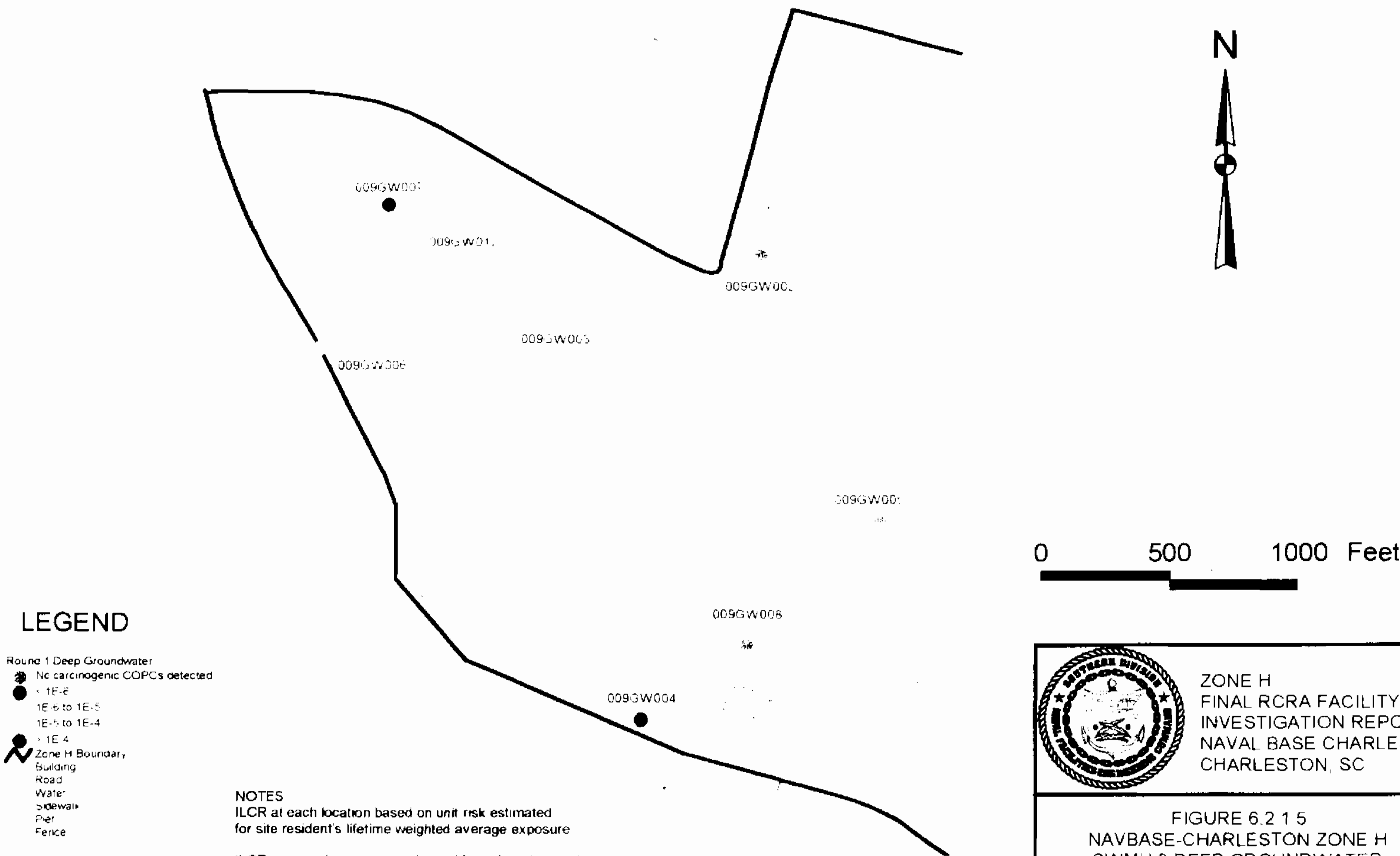
CHARLESTON, SC

FIGURE 6.2.1.4
NAVBASE-CHARLESTON ZONE H
SWMU 9 SHALLOW GROUNDWATER
2nd QUARTER
LOCATION SPECIFIC ILCR

DATE: 06/27/96	PROJ NAME: RFI009GW.APR



LEGEND

Round 1 Deep Groundwater
- No carcinogenic COPCs detected
- < 1E-6
- 1E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4
- Zone H Boundary
- Building
- Road
- Water
- Sidewalk
- Pier
- Fence

NOTES
ILCR at each location based on unit risk estimated for site resident's lifetime weighted average exposure

ILCR ranges shown were estimated based on detected concentrations of COPCs at each sample location

ZONE H
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CHARLESTON, SC

FIGURE 6.2.1.5
NAVBASE-CHARLESTON ZONE H
SWMU 9 DEEP GROUNDWATER
1ST QUARTER
LOCATION SPECIFIC ILCR

DATE 06/27/96 | PROJ NAME RFI009GW.APR

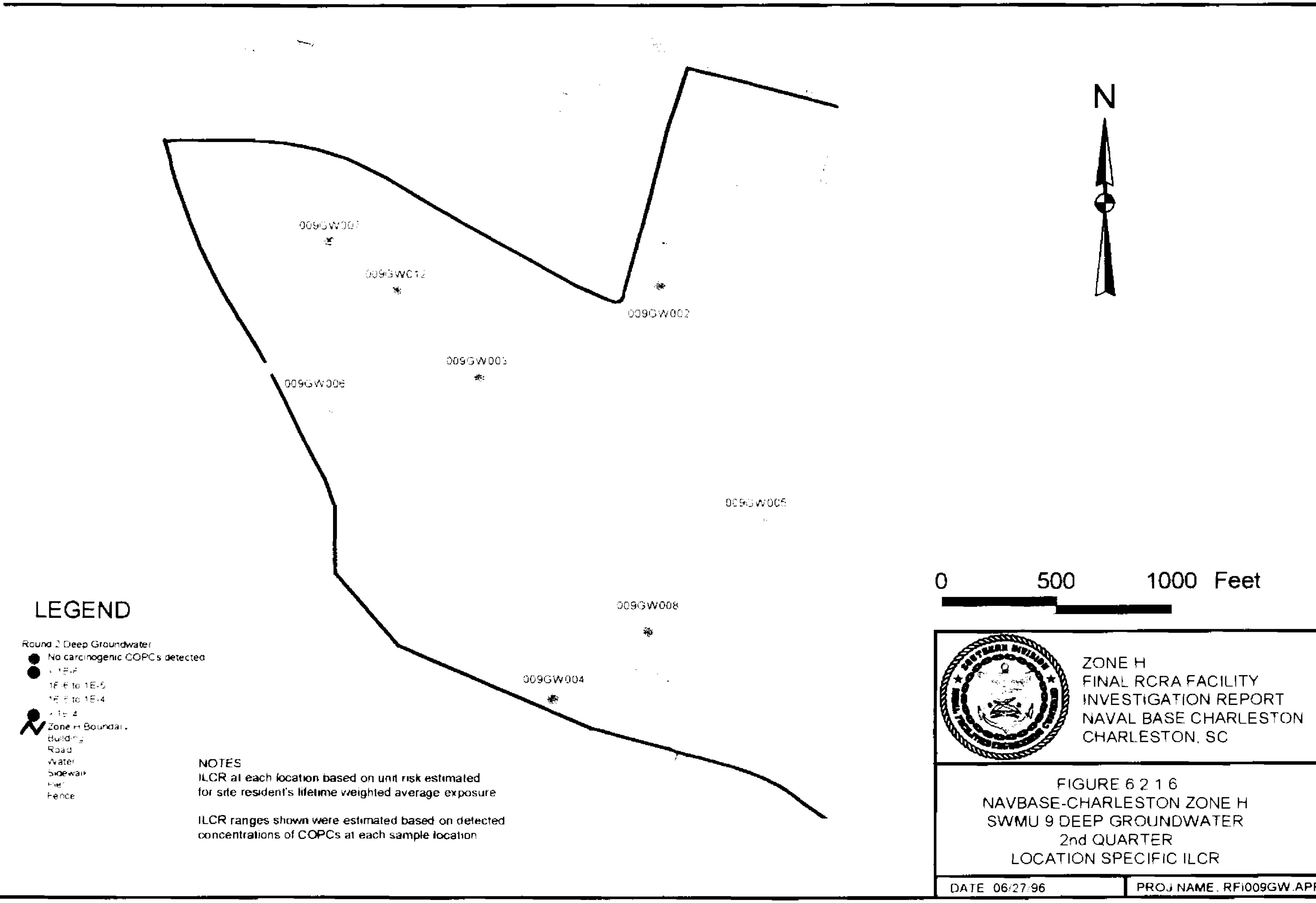
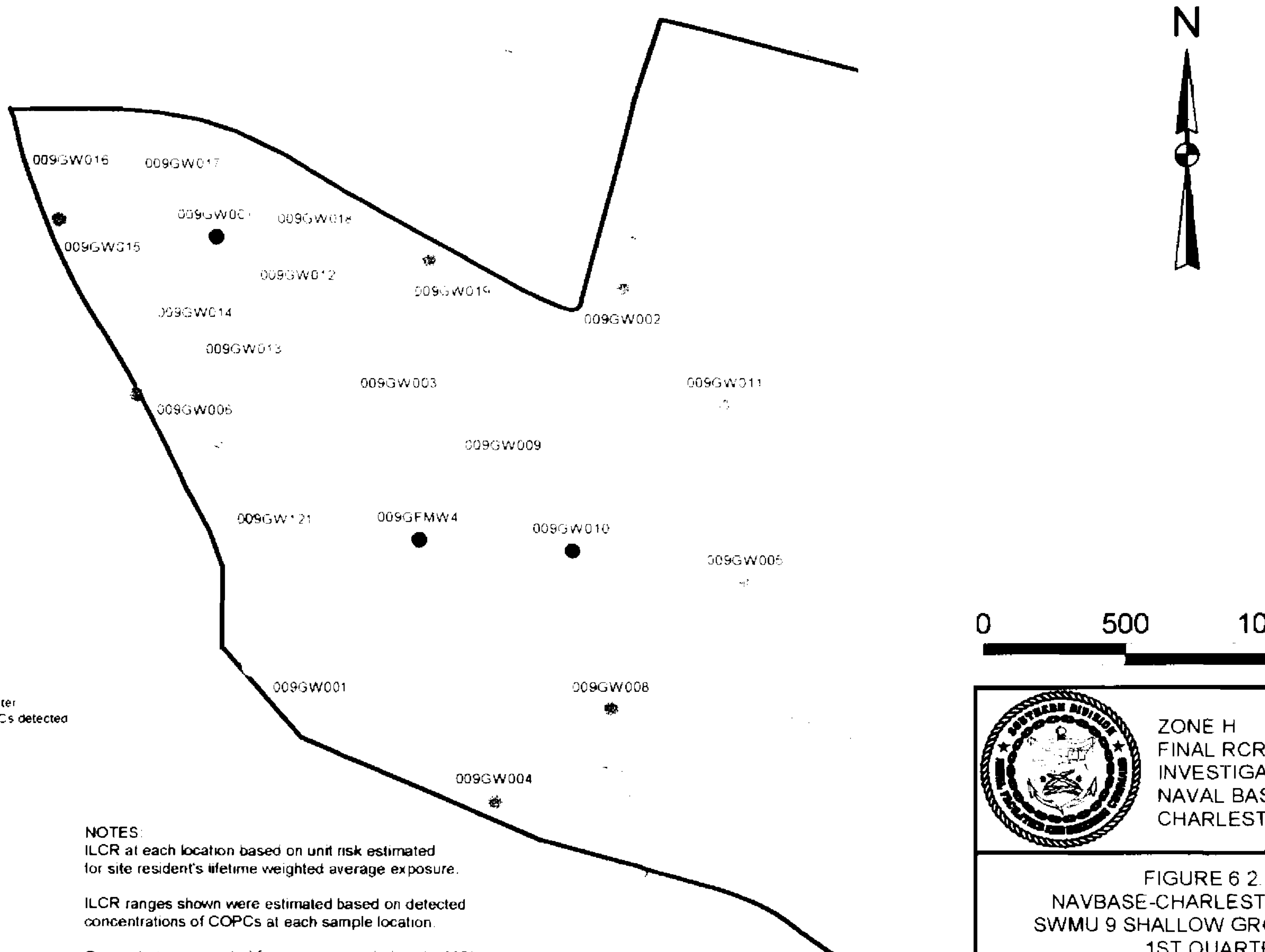


FIGURE 6 2 1 6
NAVBASE-CHARLESTON ZONE H
SWMU 9 DEEP GROUNDWATER
2nd QUARTER
LOCATION SPECIFIC ILCR



LEGEND

Round 1 Shallow Groundwater
- No carcinogenic COPCs detected
- < 1E-6
- 1E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4
- Zone H Boundary
- Building
- Road
- Water
- Sidewalk
- Pier
- Fence

NOTES:
ILCR at each location based on unit risk estimated for site resident's lifetime weighted average exposure.

ILCR ranges shown were estimated based on detected concentrations of COPCs at each sample location.

Concentrations reported for arsenic were below the MCL, and arsenic was not included in the risk estimates for each location.

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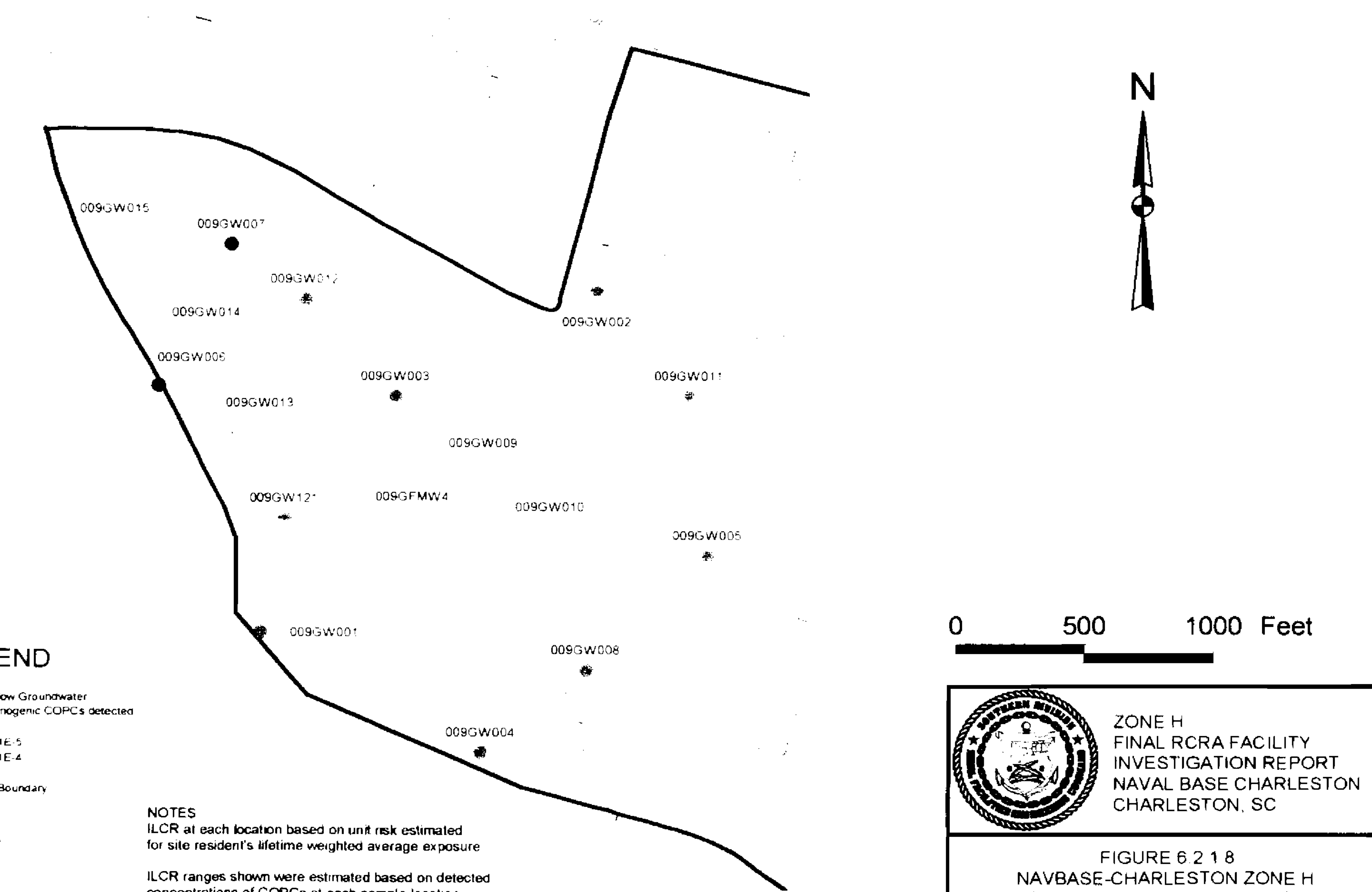
CHARLESTON, SC

FIGURE 6.2.1.7
NAVBASE-CHARLESTON ZONE H
SWMU 9 SHALLOW GROUNDWATER
1ST QUARTER
LOCATION SPECIFIC ILCR

DATE: 06/27/96	PROJ NAME: RFI009GW.APR



LEGEND

Round 2 Shallow Groundwater
- No carcinogenic COPCs detected
- < 1E-6
- 1E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4
- Zone H Boundary
- Building
- Road
- Water
- Sidewalk
- Pier
- Fence

NOTES

ILCR at each location based on unit risk estimated for site resident's lifetime weighted average exposure

ILCR ranges shown were estimated based on detected concentrations of COPCs at each sample location

Concentrations reported for arsenic were below the MCL and arsenic was not included in the Risk estimates for each location

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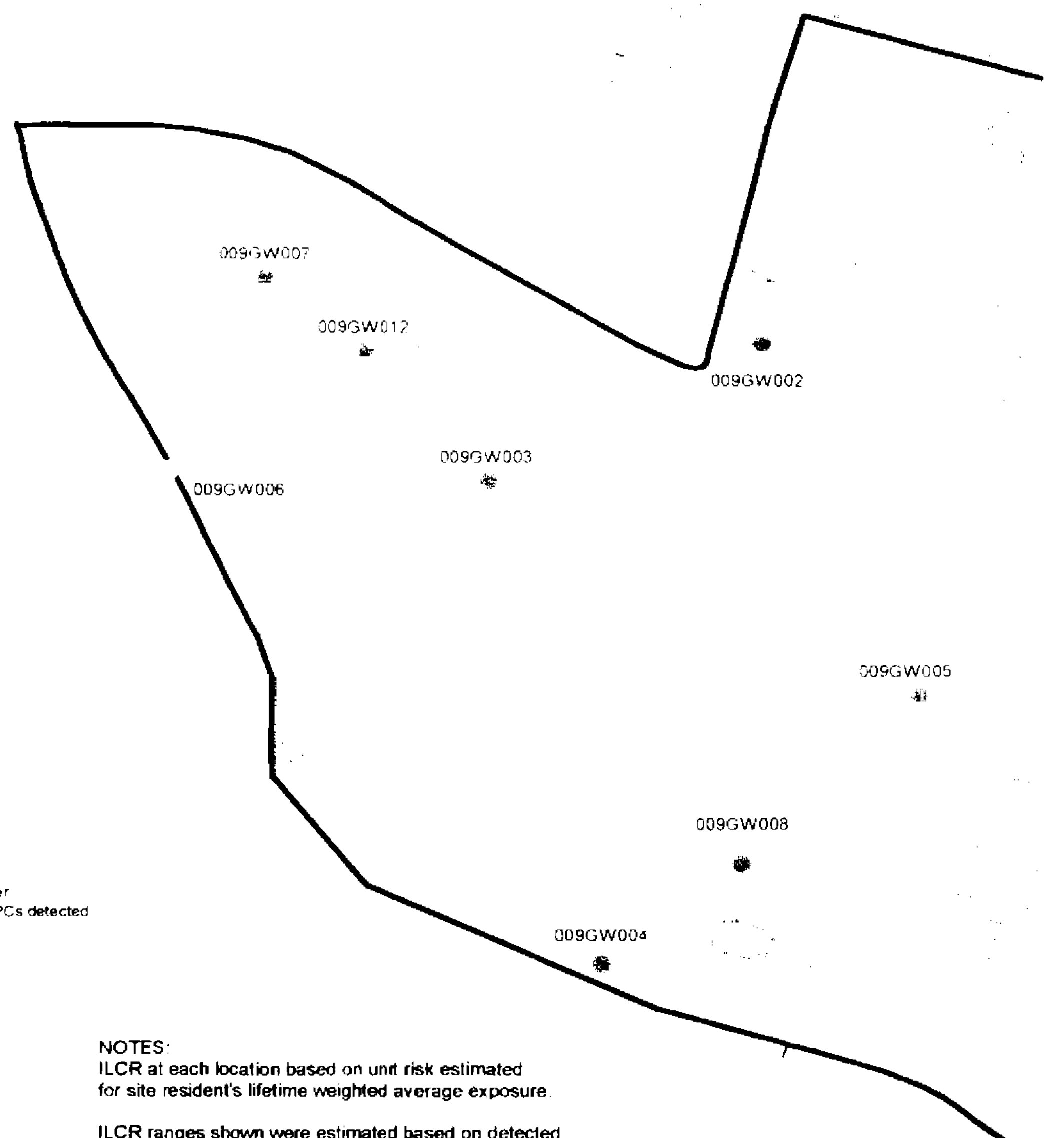
FIGURE 6.2.1.8
NAVBASE-CHARLESTON ZONE H
SWMU 9 SHALLOW GROUNDWATER
2nd QUARTER
LOCATION SPECIFIC ILCR

DATE: 06/27/96 | PROJ NAME: RFI009GW.APR



LEGEND

Round 1 Deep Groundwater
- No carcinogenic COPCs detected
- < 1E-6
- 1E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4
- Zone H Boundary
- Building
- Road
- Water
- Sidewalk
- Pier
- Fence

NOTES:
ILCR at each location based on unit risk estimated
for site resident's lifetime weighted average exposure.

ILCR ranges shown were estimated based on detected
concentrations of COPCs at each sample location.

Concentrations reported for arsenic were below the MCL,
and arsenic was not included in the risk estimates for each location.

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 6.2.1 9
NAVBASE-CHARLESTON ZONE H
SWMU 9 DEEP GROUNDWATER
1st QUARTER
LOCATION SPECIFIC ILCR

DATE: 06/27/96	PROJ NAME: RFI009GW.APR

AOC 650 (includes AOC 651)

Hypothetical Site Residents

Tables 6.2.1.53 and 6.2.1.54 present the ingestion and dermal contact risk/hazard estimates for AOC 650. The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 650 (which includes part of AOC 651) surface soil is 4E-5. The primary contributors are BEQs (3.5E-5 ILCR), while Aroclor-1254 contributes 4.9E-6 to the ILCR. The dermal pathway ILCR is 2E-5, which is also primarily attributable to BEQs.

The computed HIs for the adult and child residential ingestion exposure pathway were estimated to be 0.04 and 0.4, respectively. The dermal contact pathway HIs for the adult resident and the child scenario were estimated to be 0.03 and 0.08, respectively. Aroclor-1254 and copper were the only contributors to the HIs.

COCs identified for this scenario are: Aroclor-1254, BEQs, and copper.

Hypothetical Site Workers

Site worker ILCRs are 4E-6 and 7E-6 for the ingestion and dermal contact pathways, respectively. The HIs for the ingestion and dermal pathways are 0.01 and 0.02, respectively, for the hypothetical site worker. BEQs and Aroclor-1254 account for the ILCR, while Aroclor-1254 accounts for the HIs. The COCs identified for this scenario based on their contribution to risk/hazard are Aroclor-1254 and BEQs.

Aroclor-1254 was reported at two sample locations, and the reported concentration exceeded the corresponding RBC at 650SB002 only. The distribution of BEQs was ubiquitous — BEQs were reported in six of 10 samples, and five reported concentrations exceeded the corresponding RBC. Copper was reported in eight of 10 samples, and only one concentration exceeded the corresponding RBC (i.e., copper in sample 650SB006).

Groundwater Pathways

Groundwater at SWMU 9 is not currently used as a potable or process water source. Because SWMU 9 encompasses a large area, location-specific analysis and site-wide analysis were performed to provide a more comprehensive evaluation of the distribution of COPCs contributing to excess cancer risk. Exposure to groundwater onsite was evaluated sitewide under both residential and industrial scenarios. For these scenarios, the ingestion and inhalation (while showering) exposure pathways were evaluated assuming the site will be used for residential purposes and that an unfiltered well, drawing from the corresponding water-bearing zone (WBZ), will be the domestic water source. The ingestion and inhalation pathways were evaluated separately for shallow and deep groundwater as well as first- and second-quarter groundwater data. For noncarcinogenic contaminants evaluated relative to future site residents, HQs/HIs were computed separately to address child and adult exposure.

Assuming COPCs are equally distributed across each site (using the UCL approach), Tables 6.2.1.55 and 6.2.1.56 present the risk and hazard for the ingestion and inhalation exposure pathways, respectively, for first-quarter shallow groundwater. Second-quarter shallow groundwater ingestion and inhalation risk and hazard are presented in Tables 6.2.1.57 and 6.2.1.58, respectively. Deep groundwater risk and hazard for the ingestion and inhalation exposure pathways are shown in Tables 6.2.1.59 and 6.2.1.60, respectively, for first-quarter deep groundwater, and Table 6.2.1.61 presents the ingestion risk and hazard for second-quarter deep groundwater. No VOCs were detected in any second-quarter deep groundwater samples.

Table 6.2.1.62 presents location-specific HQ and risk estimates for each COPC detected in groundwater. Projections based on both first- and second-quarter groundwater data for shallow and deep aquifers are presented. HQs were estimated assuming a child residential exposure scenario, which includes the ingestion and inhalation (where applicable) exposure pathways. Excess cancer risks were estimated based on the lifetime weighted average of adult and child residents, which includes the inhalation exposure pathway (where applicable).

Graphical representations were developed for each well location at SWMU 9 for shallow and deep groundwater based on both first- and second-quarter results. Excess cancer risk was summed for all COPCs detected at each sample location, and well locations were labeled to distinguish cumulative risk ranges for each sample location. CPSSs exceeding RBCs in either quarter were included irrespective of background (if applicable).

Figures 6.2.1.3 and 6.2.1.4 present the location-specific risk estimated at SWMU 9 for first- and second-quarter shallow groundwater, respectively. Figures 6.2.1.5 and 6.2.1.6 present similar estimates for deep groundwater. Arsenic and beryllium were identified as major contributors to risk projections, and the concentrations reported for these COPCs were below MCLs and typically comparable to background concentrations. As a result, it was determined that graphical risk presentations excluding arsenic and beryllium ILCR contributions would assist in clarifying the groundwater risk associated with actual site impacts. Figures 6.2.1.7 and 6.2.1.8 present the location-specific risk estimated at SWMU 9 for first- and second-quarter shallow groundwater, respectively, without arsenic and beryllium contributions. Figures 6.2.1.9 and 6.2.1.10 present similar estimates for deep groundwater. Each figure is discussed in shallow and deep groundwater characterization sections where appropriate.

The tables and figures referenced in preceding groundwater discussions were used to assess risk/hazard associated with the shallow and deep WBZs at SWMU 9. Based on the quantitative risk/hazard projections and contaminant distributions (spatial and temporal), detailed analyses were performed. The following paragraphs discuss findings for shallow and deep groundwater,

Shallow Groundwater

Hypothetical Site Residents

First Quarter Sitewide

The shallow groundwater ILCR for hypothetical site residents is 1E-1 and 5E-4 for the ingestion and inhalation pathways, respectively. The primary contributor to ILCR for the ingestion pathway is benzidine, while bis(2-chloroethyl)ether accounts for most of the inhalation ILCR. Secondary contributors to ingestion ILCR are: azobenzene, 1,2-dichloroethane, benzene, 2,3,7,8-TCDD equivalents, bis(2-chloroethyl)ether, pentachlorophenol, and vinyl chloride. Azobenzene, 1,2-dichloroethane, benzene, bis(2-chloroethyl)ether, and vinyl chloride accounted for 100% of the inhalation ILCR.

The ingestion pathway HIs estimated for the adult and child are 2 and 5, respectively. The primary contributor to HI is antimony, and secondary contributors are chlorobenzene, barium, benzidine, 2,4-dimethylphenol, and 4-methylphenol. HIs estimated for the inhalation pathway are 9 and 22 for the adult and child, respectively. Hexachlorocyclopentadiene accounted for more than 85% of the HI and was detected at only one well location (009GW016). Secondary contributors to the inhalation HIs were benzene, carbon disulfide, 1,2-dichloroethene, and chlorobenzene.

Second Quarter Sitewide

The shallow groundwater ILCRs for hypothetical site residents are 2E-3 and 4E-4 for the ingestion and inhalation pathways, respectively. Arsenic, hexachlorobenzene, vinyl chloride, beryllium, 1,4-dichlorobenzene, 1,2-dichloroethane, methylene chloride, benzene, and hexachlorobutadiene accounted for more than 90% of the ILCR for the ingestion pathway. ILCR estimated for the inhalation pathway was primarily due to hexachlorobenzene and vinyl chloride. Each COPC was detected at only one well location, 009GW007 and 009GW016, respectively. Benzidine was not detected in any second-quarter groundwater sample.

The ingestion pathway HIs estimated for the adult and child are 5 and 11, respectively. The primary contributor to ingestion HI is arsenic; secondary contributors are chlorobenzene, barium, cadmium, 2,4-dimethylphenol, hexachlorobenzene, hexachlorobutadiene, and 4-methylphenol. HIs estimated for the inhalation pathway are 1 and 3 for the adult and child, respectively. Chlorobenzene accounted for approximately 50% of the HI, and secondary contributors to the inhalation HI were 1,2-dichloroethane, benzene, hexachlorobenzene, and hexachlorobutadiene. All contributors but benzene were detected in less than 15% of the wells sampled during the second quarter.

Location-Specific

First-Quarter Shallow Groundwater

Based on Figure 6.2.1.3, the cumulative ILCR was estimated to exceed 1E-6 at the following wells: 009GFMW4, 009GW001, 009GW002, 009GW003, 009GW004, 009GW005, 009GW007, 009GW009, 009GW010, 009GW012, 009GW013, 009GW014, 009GW015, 009GW016, 009GW017, 009GW018, and 009GW121. Arsenic accounts for the majority of risk estimates for first (and second) quarter shallow groundwater. Table 6.2.1.62 shows the risk estimate for each COPC at each location for shallow groundwater, and first- and second-quarter data are noted in the table.

As shown in Table 6.2.1.62, arsenic accounted for 100% of the excess risk at well locations 009GW001, 009GW009, and 009GW013. Arsenic was also a major contributor to excess risk estimates at locations 009GW002, 009GW004, and 009GW005. The maximum concentration reported for arsenic in Zone H shallow and deep groundwater does not exceed the corresponding MCL. Figure 6.2.1.7 shows the cumulative ILCR at each sample location excluding arsenic and beryllium. Cumulative ILCR computed without arsenic and beryllium was estimated to exceed 1E-6 at the following wells: 009GFMW4, 009GW001, 009GW002, 009GW003, 009GW004, 009GW005, 009GW007, 009GW009, 009GW010, 009GW012, 009GW013, 009GW014, 009GW016, 009GW017, 009GW018, and 009GW121. Although the location-specific cumulative ILCR exceeds 1E-6 at the locations mentioned earlier, ILCR exceeds 1E-4 at only three locations (i.e., wells 009GFMW4, 009GW007, and 009GW010).

At location 009GFMW4, benzidine, benzene, and 1,4-dichlorobenzene account for 100% of the estimated ILCR. Two other locations have also been impacted by VOCs and SVOCs. Vinyl chloride, bis(2-chloroethyl)ether, 1,2-dichloroethane, and benzene account for more than 1E-4 ILCR at 009GW007, while benzene, 1,4-dichlorobenzene, and BEHP account for more than 1E-4 ILCR at 009GW010. Wells 009GFMW4 and 009GW010 are near the middle of SWMU 9, and well 009GW007 is in the northeast. Wells 009GFMW4 and 009GW010 are approximately 500 feet from each other, and 009GW007 and 009GFMW4 are approximately 1,000 feet apart, with several wells between the two. Benzene was identified as a COPC in wells from the center of SWMU 9 to the central northeast portion of the SWMU. Based on first-quarter shallow groundwater monitoring data, wells 009GW007, 009GW014, 009GW012, 009GW013, 009GW003, 009GW009, 009GW121, 009GFMW4, and 009GW010 appear to have been impacted by benzene.

Total 2,3,7,8-TCDD equivalent concentrations were reported in first-quarter shallow groundwater in samples 009GW002, 009GW004, 009GW005, and 009GW016, and no reported concentration exceeded the corresponding MCL for 2,3,7,8-TCDD of 3E-8 mg/L. Arsenic contributed approximately one to two orders of magnitude more risk at locations 009GW002, 009GW004, and 009GW005 relative to the risk estimated for 2,3,7,8-TCDD equivalents. The risk estimated at 009GW016 was primarily due to pentachlorophenol, while 2,3,7,8-TCDD, azobenzene, benzene, and bis(2-ethylhexyl)phthalate accounted for the remainder of the ILCR estimated at that location. TEQs were not analyzed for second-quarter groundwater samples.

Second-Quarter Shallow Groundwater

Figure 6.2.1.4 shows the cumulative ILCR estimated to exceed 1E-6 and the corresponding shallow monitoring wells: 009GFMW4, 009GW003, 009GW005, 009GW006, 009GW007, 009GW008, 009GW009, 009GW010, 009GW011, 009GW012, 009GW013, and 009GW014. Arsenic accounts for the majority of risk estimates for first- and second-quarter shallow groundwater.

As ILCR is presented in Figure 6.2.1.8, arsenic and beryllium contributions to location-specific ILCR were excised. ILCR was estimated to exceed 1E-6 at the following shallow monitoring wells: 009GFMW4, 009GW006, 009GW007, 009GW009, 009GW010, and 009GW013. Of these locations, ILCR was estimated to exceed 1E-4 at 009GW006 and 009GW007 only. ILCR estimated for well 009GW006 was contributed by hexachlorobenzene, hexachlorobutadiene, and hexachloroethane. Arsenic was reported at this location at a concentration below its MCL. Vinyl chloride, 1,2-dichloroethane, methylene chloride, benzene, and trichloroethene account for greater than 1E-4 ILCR at location 009GW007. VOCs and SVOCs appear to have impacted the following shallow monitoring wells based on second-quarter results: 009GW007, 009GW014, 009GW013, 009GW009, 009GFMW4, and 009GW010.

In shallow groundwater, many VOCs and SVOCs were reported in both first and second quarters. Benzene, chlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,2-dichloroethene, 2,4-dimethylphenol, 4-methylphenol, and vinyl chloride were reported in both quarters. Arsenic was not reported at concentrations exceeding its MCL, and isolated shallow monitoring wells appear to have been impacted by VOCs and SVOCs. Cumulative risk estimates exceeded 1E-4 in both quarters at only one sample location (009GW007), and the remaining contributors are shown in Table 6.2.1.62.

HIs were assessed on a location-specific basis as shown in Table 6.2.1.62. The following inorganics were reported in both first- and second-shallow groundwater data: barium, copper, lead, manganese, and vanadium. Thallium significantly contributed to HIs estimated for first-quarter shallow groundwater. However, thallium was not identified as a COPC in second-quarter groundwater. HIs estimated for first- and second-quarter shallow groundwater were primarily due to manganese.

COCs identified in first-quarter shallow groundwater are: azobenzene, 1,2-dichloroethane, benzene, benzidine, 2,3,7,8-TCDD, bis(2-chloroethyl)ether, pentachlorophenol, and vinyl chloride.

COCs identified in second-quarter shallow groundwater are: chlorobenzene, 1,4-dichlorobenzene, 1,2-dichlororethane, 1,2-dichloroethene, methylene chloride, beryllium, arsenic, barium, benzene, cadmium, 2,4-dimethylphenol, hexachlorobutadiene, 4-methylphenol, vinyl chloride, and hexachlorobenzene.

Hypothetical Site Workers

First Quarter Sitewide

The estimated ILCRs for future site workers are 3E-2 and 2E-4 for the ingestion and inhalation pathways, respectively. The ingestion ILCR is primarily a result of the ILCR for benzidine, and bis(2-chloroethyl)ether is the primary contributor to inhalation ILCR. The HIs for the ingestion and inhalation exposure pathways of the site worker scenario were calculated to be 0.7 (primarily due to antimony, barium, and 4-methylphenol) and 3 (due primarily to hexachlorocyclopentadiene), respectively.

Second Quarter Sitewide

ILCR estimates are 6E-4 and 1E-4 for the ingestion and inhalation pathways, respectively. Vinyl chloride and arsenic are the primary contributors to ILCR, and secondary contributors are 1,2-dichloroethane, beryllium, benzene, and hexachlorobenzene. The ingestion and inhalation HIs are 2 and 0.5, respectively. Arsenic accounts for more than 50% of the ingestion HI, while chlorobenzene and hexachlorobenzene account for the inhalation HI. Benzidine was not detected in any second-quarter groundwater sample.

Deep Groundwater

Hypothetical Site Residents

First Quarter Sitewide

The deep groundwater ingestion ILCR for hypothetical site residents is 2E-7, and the inhalation pathway ILCR is 3E-6. The risk calculated for the each pathway is due solely to chloroform, which was detected in only one sample during the first quarter (009GW06D). Chloroform was not identified as a COPC for second-quarter deep groundwater. For the ingestion pathway, the hazard indices for the adult and child residents are 59 and 138, respectively. The primary contributor to hazard is thallium. The inhalation pathway HI is 0.6 for the adult resident, and the HI for the child resident is 1. Carbon disulfide is the primary contributor to HI and was detected in one first-quarter sample only (009GW04D), and carbon disulfide was not a deep groundwater COPC based on second-quarter deep groundwater screening.

Second Quarter Sitewide

No VOCs were identified based on second-quarter deep groundwater monitoring data. Therefore, the inhalation exposure pathway was not assessed. In addition, no carcinogenic COPCs were identified, and ILCR was not calculated. HIs for the adult and child resident were estimated to be 7 and 17, respectively. Manganese contributed more than 97% of the HI. Thallium was not detected in any second-quarter deep groundwater sample.

Location-Specific

First-Quarter Deep Groundwater

As shown in Figure 6.2.1.5, the cumulative ILCR was estimated to exceed 1E-6 at the following wells: 009GW03D, 009GW04D, 009GW06D, 009GW07D, 009GW09D, and 009GW12D.

Arsenic accounts for the majority of risk estimates for first-quarter deep groundwater. Figure 6.2.1.9 shows the cumulative ILCR estimated without arsenic. ILCR exceeds 1E-6 at only one sample location, 009GW06D, and chloroform accounts for the ILCR estimate at that location.

Second-Quarter Deep Groundwater

As shown in Figure 6.2.1.6, the cumulative ILCR was estimated to exceed 1E-6 at only one well, 009GW06D. Arsenic accounts for 100% of the risk estimated for second-quarter deep groundwater at that location. Figure 6.2.1.10 shows the cumulative ILCR estimated without arsenic. ILCR exceeds 1E-6 at only one sample location, 009GW06D, and chloroform accounts for the ILCR estimate at that location.

Table 6.2.1.62 shows the risk estimate for each COPC at each location for deep groundwater, and first- and second-quarter data are noted in the table. ILCR at two locations was estimated to equal 1E-4 in either quarter (009GW04D and 009GW06D). With the exception of location 009GW06D, arsenic was the only contributor to excess cancer risk in first- and second-quarter deep groundwater. Arsenic was not reported at concentrations exceeding the MCL in any deep groundwater sample. Chloroform was reported in the first-quarter sample from 009GW06D, and was the only contributor to risk in first-quarter groundwater other than arsenic. However, chloroform was not identified as a COPC in second-quarter deep groundwater, and arsenic accounted for 100% of the risk estimated at 009GW06D during the second quarter.

Cadmium was reported in both first-and second-quarter deep monitoring wells at SWMU 9. Cadmium was reported in only one of 20 samples during the first quarter, and was reported in four of 17 samples in the second quarter. Manganese was generally the primary contributor to hazard indices estimated for first and second-quarter deep groundwater HIs shown in Table 6.2.1.62, and thallium was a significant contributor when identified as a COPC. Thallium was not detected in second-quarter deep groundwater. Cadmium HQs were typically less than 1.0 of location-specific HIs.

Hypothetical Site Workers

First Quarter Sitewide

The estimated ILCRs for future site workers via the ingestion and inhalation pathways are 7E-8 and 9E-7, respectively. The only contributor to ILCR is chloroform, which was detected in only one sample and only during the first quarter of groundwater monitoring. The HIs for the ingestion and inhalation exposure pathways of the site worker scenario were calculated to be 21 and 0.2, respectively. Ingestion hazard is due primarily to thallium, while the largest contributor to inhalation hazard is carbon disulfide.

Second Quarter Sitewide

No VOCs were identified based on second-quarter deep groundwater monitoring data. Therefore, the inhalation exposure pathway was not assessed. In addition, no carcinogenic COPCs were identified, and ILCR was not calculated. HI for the ingestion pathway was 3 for the site worker, with manganese contributing more than 97%.

COCs identified in first-quarter deep groundwater are: cadmium, manganese, and thallium.

COCs identified in second-quarter deep groundwater are: cadmium and manganese.

6.2.1.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential and current exposure. The highly protective exposure assumptions in the site worker scenario and would tend to overestimate exposure. Current site workers are not exposed to site groundwater. They are infrequently exposed to surface soil when walking across the site, using commercial facilities, or mowing grass. Site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. Mowing grass 52 days per year would reduce exposure frequency 80% relative to the default worker assumption. As a result, estimated exposure would be proportionately reduced. The most common outdoor activities onsite are currently recreation oriented. Short-term exposure to SWMU 9 surface soil may occur when individuals use the onsite running track and ballfields. Surface soil in these areas principally is landfill material.

Residential use would not be expected based on past/current site uses and the nature of the surrounding buildings. If this historical landfill was used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change — the soil could be covered with landscaping soil, a paved driveway, and/or a house. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. No basements would be completed in light of the shallow water table and waste disposition.

The base reuse plan indicates SWMU 9 will be used as an industrial buffer zone adjacent to an intermodal railway. Cinders will be used as part of the construction materials for the railway, and railroad ties are a source for BEQs. In addition, there are no plans to use the aquifers sampled as a potable or process water source. This should be a consideration of risk management when determining whether remedial actions are warranted. Table 6.2.1.62 can be used to subtract the risk posed by individual COPCs (such as BEQs or arsenic) from the total risk at each sample location for first- and second-quarter shallow and deep groundwater.

Shallow groundwater is not currently used at SWMU 9 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone H. This system is scheduled to remain in operation under the current base reuse plan. As a result, shallow groundwater use would not be expected under future land use scenarios. Therefore, the scenario established to estimate risk and hazard associated with shallow and deep groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Soil EPCs for SWMUs 19, 20, 121, and AOC 649 are based on UCLs. Fewer than 10 samples delineate the extent of CPSSs detected at AOC 650, and the maximum reported surface soil COPC concentrations were used as EPCs there. EPCs for first- and second-quarter shallow groundwater are based on UCLs, and the maximum reported concentrations were used as the deep groundwater EPCs. The use of maximum reported concentrations could overestimate exposure and resulting risk/hazard, and the quantification of exposure when using maximum reported concentrations does not account for potential variability in the contaminant concentrations in the matrices.

Frequency of Detection and Spatial Distribution

In surface soil, several COPCs that were identified as major contributors to risk and/or hazard were detected in only a small amount of samples collected. This was detailed in individual AOC/SWMU discussions following COC identification where appropriate.

Elevated TPH results (i.e., greater than 100 mg/kg) were reported in soil samples at SWMUs 19 and 121 and AOC 649. No groundwater sample contained detectable TPH concentrations. The absence of TPH in groundwater indicates the shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of these constituents. However, TPH soil AL of 100 mg/kg has been established for NAVBASE.

Overestimation of risk/hazard is possible for both shallow and deep groundwater, as is evident by the low detection frequency COCs (i.e., less than 5%). The presence of COCs with low frequencies of detection increases the potential for variability in calculated risk/hazard for surface soil and groundwater in this HHRA. The effect of the uncertainty would likely be to overestimate risk and hazard. In addition, potable or production wells installed at the few locations with high concentrations of COCs would deplete the local contaminant source over time. Therefore, some of the probable sources would not persist for 30 years, which was the assumed exposure duration in this assessment. Thus, chronic exposure at EPCs used in this assessment is unlikely.

To further detail the distribution of contaminants in SWMU 9 groundwater and their corresponding risk/hazard, Table 6.2.1.62 was provided in addition to graphical representations of location-specific cumulative risk. Figures were provided for each quarter and WBZ. Arsenic and beryllium account for most of the cumulative risk estimates shown on the figures, and the concentrations reported for these COPCs are below their MCLs. Using Table 6.2.1.62, the risk contributed by arsenic and beryllium was subtracted from risk totals, and additional figures (Figures 6.2.1.3 through 6.2.1.10) were developed which show location-specific cumulative risk (less arsenic and beryllium contributions).

BEQs were detected frequently in surface soil in combined SWMU 9. There appears to be a correlation between elevated cPAH concentrations in surface soil and the black material with the consistency of cinders. This "coal clinker," has been used extensively across the zone for road base and general fill. Due to its coal origins and combustion generation process, the detection of cPAHs in soil mixed with the material is not unexpected. The characteristics of the material including a cinder consistency would tend to minimize coingestion with native soil. The material was present at the surface in some areas of SWMU 9 and buried beneath more recent shallow soil fill in others. As a result, constructing a comprehensive coal clinker distribution map was not possible. The existence of this material should, however, be considered in the risk management process.

The extent of COPCs is generally scattered with no coherent pattern being evident, and no plume was identified based on the distribution of COPCs in either monitored zone. In addition, COPCs in deep groundwater were not identified in shallow groundwater. Lack of a definable plume is common in dilute mixed-waste landfills. The lack of a plume and lack of consistency in the shallow to deep COPCs indicate that the landfill is not a source. The presence of coal clinker could be a source of BEQs concentrations reported at SWMU 9.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs eliminated from formal assessment because they did not exceed the corresponding RBCs, few were reported at concentrations close to the RBCs (i.e., within approximately 10% of the RBCs). This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Concentrations of aluminum, chromium, and manganese exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding reference concentrations. Therefore, they were eliminated from formal assessment based on comparisons to the reference concentrations, because they did not contribute to excess risk/hazard onsite.

CT analysis would most likely influence exposure estimates for the following sites within combined SWMU 9: AOC 649, SWMU 19, SWMU 20, and AOC 650. Reducing the exposure assumptions from RME to CT would reduce the sum ILCR estimated for AOC 649 to below the 1E-6 risk threshold. In addition, exposure estimates at SWMU 19, SWMU 20, and AOC 650 would approach the 1E-6 risk threshold.

Groundwater

Of the CPSSs eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs.

Concentrations reported for arsenic and manganese exceeded the corresponding RBCs, but maximum concentrations did not exceed the corresponding reference concentrations. Therefore, arsenic and manganese were eliminated from formal assessment based on comparisons to the reference concentrations, because they did not contribute to excess risk/hazard onsite. CT assessment of groundwater was not warranted at SWMU 9 because ILCR estimates would exceed the 1E-4 upper-bound risk range at some locations. Therefore, graphical representations of location-specific ILCR (Figures 6.2.1.3 through 6.2.1.10) were developed as an evaluative tool for risk management.

Groundwater is not currently a potable water source at Zone H, nor is it used on the naval base or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed became residential, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well was installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source. The quality of Zone H groundwater was discussed in Section 3 of this RFI, and the conclusion was reached that the groundwater is not suitable for potable use based on the water quality data presented in Section 3.2.10, Table 3.4. The nonpotability determination was made independent of site-related influences.

Although SWMU 9 will be used as an industrial buffer zone, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely overestimate exposure.

6.2.1.7 Risk Summary

The risk and hazard posed by contaminants at combined SWMU 9 were assessed for the hypothetical site worker and the hypothetical future site resident under RME assumptions. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion and inhalation were evaluated for shallow and deep groundwater based on first- and second-quarter groundwater monitoring data. Table 6.2.1.64 presents the risk pathway summary for combined SWMU 9.

6.2.1.8 Remedial Goal Options

RGOs for carcinogens in surface soil were based on the residential lifetime weighted average and the adult site worker. Hazard-based RGOs were calculated based on either the hypothetical child resident or the adult site worker, as noted in each of the corresponding tables. RGOs were developed for all COPCs, and therefore, inclusion in an RGO table does not necessarily indicate that remedial action is warranted.

Soil

SWMU 19

Tables 6.2.1.65 and 6.2.1.66 present the RGOs for SWMU 19 surface soil based on the residential and site-worker scenarios, respectively.

SWMU 20

Tables 6.2.1.67 and 6.2.1.68 present the RGOs for SWMU 20 surface soil based on the residential and site-worker scenarios, respectively.

SWMU 121

Tables 6.2.1.69 and 6.2.1.70 present the RGOs for SWMU 121 surface soil based on the residential and site-worker scenarios, respectively.

AOC 649

Tables 6.2.1.71 and 6.2.1.72 present the RGOs for SWMU 649 surface soil based on the residential and site-worker scenarios, respectively.

AOC 650

Tables 6.2.1.73 and 6.2.1.74 present the RGOs for SWMU 650 surface soil based on the residential and site-worker scenarios, respectively.

First-Quarter Shallow Groundwater

Tables 6.2.1.75 and 6.2.1.76 present the RGOs for combined SWMU 9 first-quarter shallow groundwater based on the residential and site-worker scenarios, respectively.

Second-Quarter Shallow Groundwater

Tables 6.2.1.77 and 6.2.1.78 present the RGOs for combined SWMU 9 second-quarter shallow groundwater based on the residential and site-worker scenarios, respectively.

First-Quarter Deep Groundwater

Tables 6.2.1.79 and 6.2.1.80 present the RGOs for combined SWMU 9 first-quarter deep groundwater based on the residential and site-worker scenarios, respectively.

Second-Quarter Deep Groundwater

Tables 6.2.1.81 and 6.2.1.82 present the RGOs for combined SWMU 9 second-quarter deep groundwater based on the residential and site-worker scenarios, respectively.

Table 6.2.1.1
Methods Run at SWMU 19
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Opps	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
019	B001	S	S	S	Y					S						
019	B002	B	B	B	Y	Y	Y	Y	A	B	A					
019	B003	S	S	S	Y					S						
019	B004	S	S	S	Y					S						
019	B005	S	S							S						
019	B006	S	S							S						
019	B007	S	S							S						
019	B008	S	S							S						
019	B009	S	S							S						
019	B010	S	S							S						
019	B011	S	S							S						
019	B012	S	S							S						
019	B013	S	S							S						
019	B014	B	B	A	Y	Y	Y	Y	A	B	A					
019	B015						Y									
019	B016	S	S				Y			S						
019	B017	S	S				Y			S						
019	B018	S	S				Y			S						
019	B02A													Y	Y	Y
019	B04A													Y	Y	Y

Table 6.2.1.2
Methods Run at SWMU 20
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
020	B001		S	S			Y									
020	B002		S	S												
020	B003		S	S												
020	B004		S	S												
020	B005		S	S												
020	B006		S	S												
020	B007		S	S												
020	B008		S	S												
020	B009		S	S												
020	B010		S	S												
020	B011		S	S			Y									

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.1.3
Methods Run at SWMU 121
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Opps	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
121	B001	S	S	S	Y					S						
121	B002	B	B	B	Y	Y	Y	Y	A	B	A					
121	B003	S	S	S	Y					S						
121	B004	S	S	S	Y					S						
121	B005	S	S	S	Y					S						
121	B006	S	S							S						
121	B007	S	S							S						
121	B008	S	S							S						
121	B009	S	S							S						
121	B010	S	S							S						
121	B011	S	S							S						
121	B012						Y									
121	B013	S	S				Y			S						
121	B014	S	S				Y			S						
121	B015	S	S							S						
121	B016	S	S				Y			S						
121	B017	S	S				Y			S						
121	B04A													Y	Y	Y

Table 6.2.1.5
Methods Run at AOC 650
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
650	B001	S	S	S	Y					S						
650	B002	S	S	S	Y					S						
650	B003	B	B	B	Y	Y	Y	Y	A	B	A					
650	B004	S	S	S	Y					S						
650	B005	S	S							S						
650	B006	S	S							S						
650	B007	S	S							S						
650	B009	S	S							S						
650	B010	B	B	A	Y	Y	Y	Y	A	B						
650	B04A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.1.6
Methods Run at AOC 654
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
654	B001	B	B	B	Y	Y	Y	Y	A	B	A					
654	B002	S	S	S	Y					S						
654	B003	S	S	S	Y					S						
654	B005	S	S	S	Y					S						
654	B006	S	S	S	Y					S						
654	B007	S	S	S	Y					S						
654	B05A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

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S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.1.4
Methods Run at AOC 649
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
649	B001	B	B	B	Y	Y	Y	Y	A	B	A					
649	B002	S	S	S	Y					S						
649	B003	S	S	S	Y					S						
649	B004	S	S	S	Y					S						
649	B005	S	S	S	Y					S						
649	B006	S	S							S						
649	B007	S	S							S						
649	B008	S	S							S						
649	B009	S	S							S						
649	B010	S	S							S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
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B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.1.7
Methods Run at SWMU 9 (Includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexad	Dioxin	Opps	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
009	FMW4	S	S	S	Y					S	Y					
009	W001	S	S	S	Y					S						
009	W002	B	B	B	Y	Y	Y	Y	A	B	A					
009	W003	S	S	S	Y					S						
009	W004	B	B	B	Y	Y	Y	Y	A	B						
009	W005	B	B	B	Y	Y	Y	Y	A	B	A					
009	W006	S	S	S	Y					S						
009	W007	S	S	S	Y					S						
009	W008	S	S	S						S						
009	W009	S	S	S	Y					S						
009	W010	S	S	S	Y					S						
009	W011	S	S	S	Y					S						
009	W012	S	S	S	Y					S						
009	W013	S	S	S	Y					S						
009	W014	S	S	S	Y					S						
009	W015	S	S	S	Y					S						
009	W016	B	B	B	Y	Y	Y	Y	A	B						
009	W017	S	S	S	Y					S						
009	W018	S	S	S	Y					S						
009	W019	S	S	S	Y					S						
009	W121	S	S	S	Y					S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

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- S: Analyzed for parameters on SW-846 list
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- B: Analyzed for parameters on both the SW-846 and Appendix IX lists

Blank value indicates this method of analysis was not performed

Table 6.2.1.8
Methods Run at SWMU 9 (Includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
009	FMW4	S	S	S						S				Y	Y	
009	W001	S	S	S						S				Y		
009	W002	S	S	S						S				Y		
009	W003	S	S	S						S				Y		
009	W004	S	S	S						S				Y		
009	W005	S	S	S						S				Y		
009	W006	S	S	S						S				Y		
009	W007	S	S	S						S				Y		
009	W008	S	S	S						S				Y	Y	
009	W009	S	S	S						S				Y	Y	
009	W010	S	S	S						S				Y	Y	
009	W011	S	S	S						S				Y	Y	
009	W012	S	S	S						S				Y		
009	W013	S	S	S						S				Y		
009	W014	S	S	S						S				Y		
009	W015	S	S	S						S				Y		
009	W121	S	S	S						S						
FM	W004													Y		

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

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- S: Analyzed for parameters on SW-846 list
- A: Analyzed for parameters on Appendix IX list
- B: Analyzed for parameters on both the SW-846 and Appendix IX lists
- Blank value indicates this method of analysis was not performed

Table 6.2.1.9
Methods Run at SWMU 9 (Includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Deep Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
009	W02D	S	S	S	Y					S						
009	W03D	S	S	S	Y					S						
009	W04D	S	S	S	Y					S						
009	W05D	S	S	S	Y					S						
009	W06D	S	S	S	Y					S						
009	W07D	S	S	S	Y					S						
009	W08D	S	S	S	Y					S						
009	W12D	S	S	S	Y					S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.1.10
Methods Run at SWMU 9 (Includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Deep Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
009	W02D	S	S	S						S				Y		
009	W03D	S	S	S						S				Y		
009	W04D	S	S	S						S				Y		
009	W05D	S	S	S						S				Y		
009	W06D	S	S	S						S				Y		
009	W07D	S	S	S						S				Y		
009	W08D	S	S	S						S				Y	Y	
009	W12D	S	S	S						S				Y		

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.1.11
SWMU 19
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Acenaphthene	UG/KG	2/ 17	333.00 - 850.00	200.000 - 217.000	208.500	470000.0000			
Acetone	UG/KG	4/ 5	19.80 - 19.80	20.000 - 33.000	26.250	780000.0000			
Aluminum	MG/KG	17/ 17		488.000 - 11900.000	4285.764	7800.0000	3	25310.000	
Anthracene	UG/KG	4/ 17	390.00 - 850.00	64.100 - 357.500	197.900	2300000.0000			
* Antimony	MG/KG	4/ 17	1.00 - 7.80	1.200 - 436.000	110.275	3.1000	1		
* Aroclor-1254	UG/KG	1/ 17	33.00 - 50.00	2300.000 - 2300.000	2300.000	83.0000	1		
* Aroclor-1260	UG/KG	11/ 17	40.00 - 50.00	32.000 - 560.000	197.618	83.0000	8		
* Arsenic	MG/KG	14/ 17	2.00 - 8.20	3.000 - 22.100	9.828	0.3700	14	14.810	3
Barium	MG/KG	12/ 17	5.30 - 55.10	9.300 - 128.000	59.479	550.0000		40.330	9
Benzene	UG/KG	1/ 5	5.00 - 7.00	64.000 - 64.000	64.000	22000.0000			
Benzo(g,h,i)perylene	UG/KG	3/ 17	333.00 - 850.00	110.000 - 215.000	145.000	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	17/ 17		70.146 - 808.407	243.611	88.0000	10		
Benzo(a)anthracene	UG/KG	11/ 17	390.00 - 750.00	100.000 - 810.500	286.272				
Benzo(b)fluoranthene	UG/KG	12/ 17	390.00 - 480.00	100.000 - 935.000	315.583				
Chrysene	UG/KG	14/ 17	390.00 - 480.00	92.000 - 737.500	277.000				
Indeno(1,2,3-cd)pyrene	UG/KG	3/ 17	333.00 - 850.00	91.000 - 220.000	143.666				
Benzo(k)fluoranthene	UG/KG	9/ 17	390.00 - 750.00	110.000 - 712.000	345.388				
Benzo(a)pyrene	UG/KG	10/ 17	390.00 - 750.00	110.000 - 604.000	286.150				
* Beryllium	MG/KG	15/ 17	0.31 - 0.38	0.150 - 3.000	0.750	0.1500	15	1.470	1
Butylbenzylphthalate	UG/KG	8/ 17	390.00 - 750.00	110.000 - 2300.000	755.875	1600000.0000			
Cadmium	MG/KG	11/ 17	0.14 - 1.00	0.360 - 1.700	0.772	3.9000		1.050	3
Calcium	MG/KG	17/ 17		933.000 - 135000.000	24610.764				
Carbon disulfide	UG/KG	1/ 5	5.00 - 7.00	9.900 - 9.900	9.900	780000.0000			
alpha-Chlordane	UG/KG	3/ 5	4.00 - 4.00	2.000 - 9.350	5.016	470.0000			
gamma-Chlordane	UG/KG	3/ 5	4.00 - 4.00	2.700 - 4.000	3.233	470.0000			
Chlorobenzene	UG/KG	1/ 5	5.00 - 7.00	64.000 - 64.000	64.000	160000.0000			
Chloroform	UG/KG	1/ 5	5.00 - 7.00	1.500 - 1.500	1.500	78000.0000			
Chromium	MG/KG	16/ 17	2.10 - 2.10	4.300 - 46.100	24.703	39.0000	3	85.650	
Cobalt	MG/KG	15/ 17	1.20 - 4.30	1.300 - 43.300	8.310	470.0000		5.860	4
* Copper	MG/KG	15/ 17	6.60 - 11.60	5.900 - 3040.000	747.960	290.0000	9	27.600	14
2,4-D	UG/KG	1/ 2	250.00 - 250.00	41.800 - 41.800	41.800	78000.0000			
4,4'-DDD	UG/KG	2/ 5	7.00 - 9.00	2.000 - 6.000	4.000	2700.0000			
4,4'-DDE	UG/KG	2/ 5	3.30 - 4.00	4.000 - 5.000	4.500	1900.0000			
4,4'-DDT	UG/KG	1/ 5	7.00 - 9.80	16.000 - 16.000	16.000	1900.0000			

Table 6.2.1.11
SWMU 19
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Dibenzofuran	UG/KG	2/ 17	390.00 -	850.00	44.800 -	124.000	84.400	31000.0000			
Di-n-butylphthalate	UG/KG	4/ 17	330.00 -	850.00	110.000 -	1100.000	375.750	780000.0000			
1,1-Dichloroethene	UG/KG	2/ 5	5.00 -	7.00	3.500 -	63.000	33.250	1100.0000			
Di-n-octylphthalate	UG/KG	1/ 17	330.00 -	850.00	150.000 -	150.000	150.000	160000.0000			
Dioxin (TCDD TEQ)	PG/G	6/ 6			1.058 -	45.608	21.076	1000.0000			
Endosulfan II	UG/KG	1/ 5	7.00 -	9.00	2.100 -	2.100	2.100	47000.0000			
Endrin aldehyde	UG/KG	3/ 5	7.00 -	9.00	14.000 -	52.000	32.400	2300.0000h			
bis(2-Ethylhexyl)phthalate	UG/KG	10/ 17	390.00 -	750.00	160.000 -	9700.000	1873.600	46000.0000			
Fluoranthene	UG/KG	14/ 17	390.00 -	480.00	98.000 -	1590.000	514.500	310000.0000			
Fluorene	UG/KG	3/ 17	390.00 -	850.00	40.600 -	218.500	153.033	310000.0000			
* Indeterminate Gasoline Fuel	UG/KG	1/ 1			79000.000 -	79000.000	79000.000	10.0000	1		
* Indeterminate Lubricating Oil	UG/KG	1/ 1			110000.000 -	110000.000	110000.000	10.0000	1		
Iron	MG/KG	17/ 17			1470.000 -	26300.000	11265.882			30910.000	
* Lead	MG/KG	16/ 17	7.60 -	7.60	3.400 -	6170.000	575.587	400.0000j	3	118.000	9
Magnesium	MG/KG	17/ 17			54.800 -	4370.000	1686.282			9592.000	
Manganese	MG/KG	16/ 17	4.80 -	4.80	36.700 -	320.000	118.600	39.0000	15	636.400	
Mercury	MG/KG	14/ 17	0.02 -	0.04	0.040 -	2.100	0.328	2.3000		0.490	2
2-Methylnaphthalene	UG/KG	4/ 17	390.00 -	850.00	100.000 -	240.000	180.000	310000.0000i			
4-Methylphenol	UG/KG	2/ 17	330.00 -	850.00	125.000 -	200.000	162.500	39000.0000			
Naphthalene	UG/KG	3/ 17	390.00 -	850.00	140.000 -	480.000	265.000	310000.0000			
* Nickel	MG/KG	15/ 17	2.70 -	3.90	2.700 -	282.000	61.280	160.0000	1	33.380	7
Phenanthrene	UG/KG	13/ 17	390.00 -	750.00	100.000 -	1195.000	405.423	310000.0000k			
Phenol	UG/KG	1/ 17	333.00 -	850.00	100.000 -	100.000	100.000	4700000.0000			
Potassium	MG/KG	3/ 17	117.00 -	606.00	608.000 -	1510.000	1038.333				
Pyrene	UG/KG	14/ 17	390.00 -	480.00	110.000 -	1430.000	522.464	230000.0000			
Selenium	MG/KG	7/ 17	0.30 -	1.70	0.380 -	1.100	0.835	39.0000		2.000	
Silver	MG/KG	1/ 17	0.16 -	0.94	0.920 -	0.920	0.920	39.0000			
Sodium	MG/KG	14/ 17	24.60 -	199.00	35.100 -	479.000	190.957				
* Petroleum Hydrocarbons, TPH	MG/KG	1/ 1			170.000 -	170.000	170.000	10.0000	1		
Thallium	MG/KG	1/ 17	0.29 -	0.68	0.320 -	0.320	0.320	0.6300		0.630	
Tin	MG/KG	2/ 2			5.900 -	43.800	24.850	4700.0000			
Toluene	UG/KG	5/ 5			5.000 -	72.000	19.810	1600000.0000			
Trichloroethene	UG/KG	2/ 5	5.00 -	7.00	1.300 -	54.000	27.650	47000.0000			
Vanadium	MG/KG	16/ 17	3.90 -	3.90	4.300 -	43.500	17.506	55.0000		77.380	

Table 6.2.1.11
SWMU 19
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Xylene (total)	UG/KG	1/ 5	5.00 - 7.00	1.600 - 1.600	1.600	16000000.0000			
* Zinc	MG/KG	15/ 17	11.90 - 250.00	12.300 - 2800.000	606.233	2300.0000	1	214.300	12

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- h Endrin used as surrogate
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.1.12
SWMU 20
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Acenaphthene	UG/KG	2/ 11	330.00 - 420.00	100.000 - 210.000	155.000	470000.0000			
Anthracene	UG/KG	4/ 11	330.00 - 420.00	74.000 - 450.000	251.000	2300000.0000			
Benzo(g,h,i)perylene	UG/KG	5/ 11	330.00 - 420.00	78.000 - 250.000	159.800	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	11/ 11		94.905 - 1120.840	400.944	88.0000	11		
Benzo(a)anthracene	UG/KG	10/ 11	330.00 - 330.00	79.000 - 950.000	312.000				
Benzo(b)fluoranthene	UG/KG	10/ 11	330.00 - 330.00	110.000 - 1400.000	407.000				
Chrysene	UG/KG	10/ 11	330.00 - 330.00	110.000 - 940.000	348.500				
Dibenzo(a,h)anthracene	UG/KG	2/ 11	330.00 - 420.00	75.000 - 100.000	87.500				
Indeno(1,2,3-cd)pyrene	UG/KG	5/ 11	330.00 - 420.00	78.000 - 260.000	167.800				
Benzo(k)fluoranthene	UG/KG	10/ 11	330.00 - 330.00	100.000 - 660.000	291.000				
Benzo(a)pyrene	UG/KG	9/ 11	330.00 - 380.00	87.000 - 820.000	326.888				
Butylbenzylphthalate	UG/KG	2/ 11	330.00 - 420.00	91.000 - 190.000	140.500	1600000.0000			
Dibenzofuran	UG/KG	2/ 11	330.00 - 420.00	89.000 - 220.000	154.500	31000.0000			
Dioxin (TCDD TEQ)	PG/G	2/ 2		1.340 - 6.308	3.824	1000.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	9/ 11	360.00 - 390.00	110.000 - 8165.000	1226.111	46000.0000			
Fluoranthene	UG/KG	10/ 11	330.00 - 330.00	140.000 - 2000.000	659.500	310000.0000			
Fluorene	UG/KG	2/ 11	330.00 - 420.00	140.000 - 340.000	240.000	310000.0000			
2-Methylnaphthalene	UG/KG	1/ 11	330.00 - 390.00	100.000 - 100.000	100.000	310000.0000i			
Naphthalene	UG/KG	1/ 11	330.00 - 420.00	99.000 - 99.000	99.000	310000.0000			
Phenanthrene	UG/KG	9/ 11	330.00 - 380.00	110.000 - 1900.000	523.888	310000.0000k			
Pyrene	UG/KG	10/ 11	330.00 - 330.00	200.000 - 2800.000	746.000	230000.0000			
Toluene	UG/KG	10/ 11	6.00 - 6.00	2.800 - 11.000	5.860	1600000.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- i Naphthalene used as surrogate
- k Fluoranthene used as surrogate

Table B2.1-13
SWMU 121
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Diethylphthalate	UG/KG	1/ 16	360.00 -	1600.00	85.200 -	85.200	85.200	6300000.0000			
Dioxin (TCDD TEQ)	PG/G	6/ 6			17.818 -	195.637	103.557	1000.0000			
Endosulfan II	UG/KG	2/ 5	8.00 -	8.00	24.000 -	25.000	24.500	47000.0000			
Endrin aldehyde	UG/KG	1/ 5	8.00 -	8.00	24.300 -	24.300	24.300	2300.0000h			
bis(2-Ethylhexyl)phthalate	UG/KG	9/ 16	360.00 -	450.00	62.000 -	1000.000	332.666	46000.0000			
Fluoranthene	UG/KG	11/ 16	360.00 -	1600.00	120.000 -	3900.000	856.090	310000.0000			
Fluorene	UG/KG	1/ 16	330.00 -	1600.00	200.000 -	200.000	200.000	310000.0000			
Iron	MG/KG	16/ 16			2230.000 -	80800.000	25810.625			30910.000	4
* Lead	MG/KG	16/ 16			40.600 -	2770.000	539.181	400.0000j	8	118.000	13
Magnesium	MG/KG	16/ 16			284.000 -	4190.000	1930.812			9592.000	
* Manganese	MG/KG	16/ 16			20.700 -	1020.000	262.406	39.0000	14	636.400	1
* Mercury	MG/KG	16/ 16			0.030 -	3.500	0.965	2.3000	2	0.490	9
4-Methyl-2-Pentanone (MIBK)	UG/KG	1/ 5	27.00 -	30.00	2.400 -	2.400	2.400	390000.0000			
2-Methylnaphthalene	UG/KG	2/ 16	330.00 -	1600.00	110.000 -	470.000	290.000	310000.0000i			
Naphthalene	UG/KG	1/ 16	330.00 -	1600.00	330.000 -	330.000	330.000	310000.0000			
* Nickel	MG/KG	16/ 16			4.600 -	995.000	212.506	160.0000	8	33.380	13
Phenanthrene	UG/KG	9/ 16	360.00 -	1600.00	85.000 -	2200.000	511.533	310000.0000k			
Potassium	MG/KG	3/ 16	132.00 -	690.00	739.000 -	1130.000	915.333				
Pyrene	UG/KG	12/ 16	360.00 -	1600.00	93.000 -	3400.000	796.333	230000.0000			
Selenium	MG/KG	10/ 16	0.30 -	4.50	0.410 -	3.200	1.246	39.0000		2.000	2
Silver	MG/KG	6/ 16	0.16 -	1.50	0.330 -	1.200	0.775	39.0000			
Sodium	MG/KG	16/ 16			39.000 -	1600.000	387.887				
* Petroleum Hydrocarbons, TPH	MG/KG	1/ 1			150.000 -	150.000	150.000	10.0000	1		
* Thallium	MG/KG	1/ 16	0.31 -	2.50	2.700 -	2.700	2.700	0.6300	1	0.630	1
Tin	MG/KG	1/ 1			19.700 -	19.700	19.700	4700.0000			
Toluene	UG/KG	3/ 5	6.00 -	6.00	3.750 -	13.000	7.583	1600000.0000			
* Vanadium	MG/KG	16/ 16			6.200 -	470.000	93.100	55.0000	7	77.380	5
Xylene (total)	UG/KG	2/ 5	6.00 -	6.00	2.400 -	6.000	4.200	16000000.0000			
* Zinc	MG/KG	16/ 16			79.000 -	15100.000	2865.437	2300.0000	7	214.300	15

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- e Acenaphthene used as surrogate
- f Fluoranthene used as surrogate
- h Endrin used as surrogate
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.1.13
SWMU 121
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/KG	1/ 16	330.00 -	1600.00	130.000 -	130.000	130.000	470000.0000			
Acenaphthylene	UG/KG	2/ 16	330.00 -	1600.00	160.000 -	590.000	375.000	470000.0000e			
Acetone	UG/KG	4/ 5	30.00 -	30.00	15.000 -	193.500	68.125	780000.0000			
Acrylonitrile	UG/KG	1/ 1			34.500 -	34.500	34.500	1200.0000			
Aluminum	MG/KG	16/ 16			719.000 -	16000.000	6536.812	7800.0000	5	25310.000	
Anthracene	UG/KG	6/ 16	330.00 -	1600.00	100.000 -	610.000	243.333	2300000.0000			
* Antimony	MG/KG	4/ 16	0.99 -	18.90	2.800 -	7.300	4.525	3.1000	3		
* Aroclor-1248	UG/KG	4/ 16	40.00 -	200.00	66.000 -	160.000	116.500	83.0000	3		
* Aroclor-1254	UG/KG	7/ 16	40.00 -	40.00	140.000 -	4300.000	914.285	83.0000	7		
* Aroclor-1260	UG/KG	12/ 16	40.00 -	40.00	110.000 -	1100.000	295.833	83.0000	12		
* Arsenic	MG/KG	11/ 16	1.60 -	13.50	3.500 -	18.700	8.636	0.3700	11	14.810	1
Barium	MG/KG	14/ 16	0.49 -	35.60	19.000 -	530.000	149.878	550.0000		40.330	12
Benzo(g,h,i)perylene	UG/KG	6/ 16	360.00 -	1600.00	72.350 -	780.000	348.725	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	16/ 16			99.818 -	2524.900	557.498	88.0000	16		
Benzo(a)anthracene	UG/KG	8/ 16	360.00 -	1600.00	93.000 -	1900.000	692.937				
Benzo(b)fluoranthene	UG/KG	11/ 16	360.00 -	1600.00	92.000 -	2700.000	808.136				
Chrysene	UG/KG	10/ 16	360.00 -	1600.00	87.000 -	2000.000	618.250				
Dibenzo(a,h)anthracene	UG/KG	5/ 16	330.00 -	1600.00	98.000 -	280.000	171.600				
Indeno(1,2,3-cd)pyrene	UG/KG	6/ 16	360.00 -	1600.00	53.600 -	750.000	358.933				
Benzo(k)fluoranthene	UG/KG	8/ 16	360.00 -	1600.00	69.000 -	2200.000	534.437				
Benzo(a)pyrene	UG/KG	10/ 16	360.00 -	1600.00	77.000 -	1700.000	549.435				
* Beryllium	MG/KG	16/ 16			0.160 -	14.600	2.911	0.1500	16	1.470	9
2-Butanone (MEK)	UG/KG	1/ 5	27.00 -	30.00	37.100 -	37.100	37.100	4700000.0000			
Butylbenzylphthalate	UG/KG	4/ 16	360.00 -	1600.00	88.000 -	2600.000	782.000	1600000.0000			
Cadmium	MG/KG	12/ 16	0.17 -	1.10	0.630 -	2.500	1.302	3.9000		1.050	7
Calcium	MG/KG	16/ 16			6530.000 -	313000.000	67244.375				
gamma-Chlordane	UG/KG	1/ 5	4.00 -	4.00	4.000 -	4.000	4.000	470.0000			
* Chromium	MG/KG	16/ 16			7.800 -	210.000	51.487	39.0000	9	85.650	1
Cobalt	MG/KG	16/ 16			1.000 -	97.200	18.803	470.0000		5.860	12
* Copper	MG/KG	15/ 16	27.60 -	27.60	60.000 -	4060.000	926.406	290.0000	12	27.600	15
Cyanide	MG/KG	1/ 5	1.00 -	1.00	9.900 -	9.900	9.900	160.0000			
4,4'-DDE	UG/KG	3/ 5	4.00 -	4.00	3.000 -	20.500	8.833	1900.0000			
4,4'-DDT	UG/KG	1/ 5	8.00 -	8.00	14.000 -	14.000	14.000	1900.0000			
Dibenzofuran	UG/KG	1/ 16	330.00 -	1600.00	89.000 -	89.000	89.000	31000.0000			

Table 6.2.1.15
AOC 650
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acrylonitrile	UG/KG	1/ 2	10.00 -	10.00	36.900 -	36.900	36.900	1200.0000			
Aluminum	MG/KG	9/ 9			1960.000 -	6000.000	3763.333	7800.0000		25310.000	
Anthracene	UG/KG	2/ 9	333.00 -	450.00	86.500 -	250.000	168.250	2300000.0000			
Antimony	MG/KG	2/ 9	0.74 -	4.50	0.740 -	1.600	1.170	3.1000			
* Aroclor-1254	UG/KG	2/ 9	40.00 -	76.00	51.000 -	407.000	229.000	83.0000	1		
Arsenic	MG/KG	4/ 9	1.30 -	13.60	2.100 -	8.000	3.825	0.3700	4	14.810	
Barium	MG/KG	5/ 9	5.00 -	28.60	8.900 -	57.900	29.580	550.0000		40.330	1
Benzo(g,h,i)perylene	UG/KG	2/ 9	333.00 -	450.00	525.000 -	1100.000	812.500	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	9/ 9			236.288 -	3072.900	692.502	88.0000	9		
Benzo(a)anthracene	UG/KG	5/ 9	333.00 -	450.00	85.900 -	1900.000	593.400				
Benzo(b)fluoranthene	UG/KG	4/ 9	333.00 -	450.00	173.000 -	4000.000	1512.250				
Chrysene	UG/KG	5/ 9	333.00 -	450.00	86.100 -	1900.000	463.420				
Dibenzo(a,h)anthracene	UG/KG	1/ 9	333.00 -	450.00	390.000 -	390.000	390.000				
Indeno(1,2,3-cd)pyrene	UG/KG	2/ 9	333.00 -	450.00	438.000 -	910.000	674.000				
Benzo(a)pyrene	UG/KG	4/ 9	333.00 -	450.00	80.300 -	2000.000	716.575				
Benzoic acid	UG/KG	3/ 9	2000.00 -	2300.00	103.000 -	269.000	162.333	31000000.0000			
Beryllium	MG/KG	9/ 9			0.080 -	1.100	0.448	0.1500	7	1.470	
Butylbenzylphthalate	UG/KG	4/ 9	333.00 -	450.00	322.000 -	1540.000	691.000	1600000.0000			
Cadmium	MG/KG	5/ 9	0.09 -	0.53	0.130 -	0.390	0.218	3.9000		1.050	
Calcium	MG/KG	9/ 9			1580.000 -	114000.000	23165.555				
alpha-Chlordane	UG/KG	3/ 9	4.00 -	4.00	1.800 -	11.600	7.800	470.0000			
gamma-Chlordane	UG/KG	2/ 9	4.00 -	4.00	1.300 -	6.000	3.650	470.0000			
Chlorobenzene	UG/KG	1/ 5	5.00 -	6.30	5.180 -	5.180	5.180	160000.0000			
Chromium	MG/KG	9/ 9			5.300 -	24.400	11.883	39.0000		85.650	
Cobalt	MG/KG	8/ 9	1.60 -	1.60	0.570 -	9.500	3.667	470.0000		5.860	2
* Copper	MG/KG	7/ 9	3.60 -	4.30	68.100 -	357.000	193.871	290.0000	1	27.600	7
4,4'-DDD	UG/KG	1/ 9	7.30 -	9.00	2.400 -	2.400	2.400	2700.0000			
4,4'-DDE	UG/KG	2/ 9	4.00 -	4.20	6.750 -	10.000	8.375	1900.0000			
4,4'-DDT	UG/KG	2/ 9	7.30 -	9.00	6.000 -	7.000	6.500	1900.0000			
Dibenzofuran	UG/KG	1/ 9	333.00 -	450.00	42.900 -	42.900	42.900	31000.0000			
Di-n-butylphthalate	UG/KG	3/ 9	333.00 -	450.00	74.400 -	222.000	125.400	780000.0000			
1,1-Dichloroethene	UG/KG	1/ 5	5.00 -	6.30	1.900 -	1.900	1.900	1100.0000			
Di-n-octylphthalate	UG/KG	1/ 9	333.00 -	450.00	98.000 -	98.000	98.000	160000.0000			
Dioxin (TCDD TEQ)	PG/G	2/ 2			1.061 -	4.907	2.984	1000.0000			

Table 6.2.1.15
AOC 650
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Endosulfan sulfate	UG/KG	1/ 9	3.30 - 9.00	7.000 - 7.000	7.000	47000.0000g			
bis(2-Ethylhexyl)phthalate	UG/KG	4/ 9	333.00 - 450.00	100.000 - 504.000	229.750	46000.0000			
Fluoranthene	UG/KG	6/ 9	333.00 - 430.00	110.000 - 3200.000	997.166	310000.0000			
Iron	MG/KG	9/ 9		1640.000 - 16200.000	6350.000			30910.000	
Lead	MG/KG	8/ 9	5.80 - 5.80	7.700 - 347.000	130.893	400.0000j		118.000	4
Magnesium	MG/KG	9/ 9		130.000 - 1360.000	521.888			9592.000	
Manganese	MG/KG	9/ 9		13.200 - 79.900	40.900	39.0000	4	636.400	
Mercury	MG/KG	7/ 9	0.03 - 0.03	0.020 - 0.610	0.180	2.3000		0.490	1
2-Methylnaphthalene	UG/KG	2/ 9	333.00 - 450.00	158.000 - 322.000	240.000	310000.0000i			
Naphthalene	UG/KG	2/ 9	333.00 - 450.00	114.000 - 270.000	192.000	310000.0000			
Nickel	MG/KG	9/ 9		0.980 - 39.200	15.208	160.0000		33.380	1
Phenanthrene	UG/KG	5/ 9	333.00 - 450.00	97.100 - 800.000	356.680	310000.0000k			
Potassium	MG/KG	5/ 9	121.00 - 492.00	178.000 - 819.000	386.600				
Pyrene	UG/KG	7/ 9	333.00 - 430.00	86.900 - 3300.000	838.700	230000.0000			
Selenium	MG/KG	2/ 9	0.16 - 0.35	0.290 - 0.420	0.355	39.0000		2.000	
Sodium	MG/KG	9/ 9		33.100 - 308.000	141.077				
* Petroleum Hydrocarbons, TPH	MG/KG	1/ 1		980.000 - 980.000	980.000	10.0000	1		
Thallium	MG/KG	2/ 9	0.16 - 0.61	0.490 - 0.540	0.515	0.6300		0.630	
Toluene	UG/KG	2/ 5	6.00 - 6.30	2.400 - 5.900	4.150	1600000.0000			
Vanadium	MG/KG	9/ 9		6.500 - 22.800	10.566	55.0000		77.380	
Zinc	MG/KG	9/ 9		6.600 - 507.000	202.433	2300.0000		214.300	4

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- g Endosulfan used as surrogate
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.1.16
AOC 654
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Acetone	UG/KG	4/ 6	14.00 - 24.00	52.000 - 4000.000	1045.750	780000.0000			
Aluminum	MG/KG	6/ 6		2830.000 - 6890.000	4813.333	7800.0000		25310.000	
Arsenic	MG/KG	6/ 6		2.200 - 7.700	4.600	0.3700	6	14.810	
delta-BHC	UG/KG	1/ 6	4.00 - 5.00	1.200 - 1.200	1.200	490.0000			
Barium	MG/KG	4/ 6	0.46 - 0.62	11.800 - 38.700	20.900	550.0000		40.330	
Benzo(a)pyrene Equivalents	UG/KG	6/ 6		5.500 - 11.000	6.416	88.0000			
Beryllium	MG/KG	6/ 6		0.170 - 0.490	0.341	0.1500	6	1.470	
Cadmium	MG/KG	2/ 6	0.16 - 1.10	0.560 - 0.970	0.765	3.9000		1.050	
Calcium	MG/KG	6/ 6		15000.000 - 219000.000	102183.333				
alpha-Chlordane	UG/KG	1/ 6	4.00 - 5.00	69.100 - 69.100	69.100	470.0000			
gamma-Chlordane	UG/KG	1/ 6	4.00 - 5.00	40.850 - 40.850	40.850	470.0000			
Chromium	MG/KG	6/ 6		11.000 - 53.300	30.016	39.0000	3	85.650	
Cobalt	MG/KG	6/ 6		0.480 - 3.100	1.413	470.0000		5.860	
Copper	MG/KG	6/ 6		1.600 - 57.100	14.450	290.0000		27.600	1
Cyanide	MG/KG	1/ 6	0.90 - 1.00	2.000 - 2.000	2.000	160.0000			
4,4'-DDE	UG/KG	1/ 6	4.00 - 5.00	6.150 - 6.150	6.150	1900.0000			
4,4'-DDT	UG/KG	1/ 6	8.00 - 10.00	10.000 - 10.000	10.000	1900.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1		0.716 - 0.716	0.716	1000.0000			
Endrin	UG/KG	1/ 6	4.00 - 5.00	2.000 - 2.000	2.000	2300.0000			
Ethylbenzene	UG/KG	1/ 6	6.00 - 900.00	4.500 - 4.500	4.500	780000.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	1/ 6	410.00 - 500.00	117.000 - 117.000	117.000	46000.0000			
Fluoranthene	UG/KG	2/ 6	330.00 - 500.00	110.000 - 110.000	110.000	310000.0000			
Heptachlor	UG/KG	1/ 6	4.00 - 5.00	1.100 - 1.100	1.100	140.0000			
Heptachlor epoxide	UG/KG	1/ 6	4.00 - 5.00	4.100 - 4.100	4.100	70.0000			
Iron	MG/KG	6/ 6		3050.000 - 6050.000	4445.000			30910.000	
Lead	MG/KG	1/ 6	6.20 - 11.70	32.700 - 32.700	32.700	400.0000		118.000	
Magnesium	MG/KG	6/ 6		496.000 - 7720.000	3747.833			9592.000	
Manganese	MG/KG	6/ 6		19.100 - 57.200	37.300	39.0000	3	636.400	
Mercury	MG/KG	3/ 6	0.02 - 0.03	0.110 - 0.230	0.160	2.3000		0.490	
Methylene chloride	UG/KG	1/ 6	5.20 - 1800.00	25.000 - 25.000	25.000	85000.0000			
Nickel	MG/KG	6/ 6		2.400 - 17.900	9.983	160.0000		33.380	
Potassium	MG/KG	6/ 6		189.000 - 1140.000	568.166				
Selenium	MG/KG	2/ 6	0.31 - 1.60	1.200 - 2.600	1.900	39.0000		2.000	1
Sodium	MG/KG	6/ 6		129.000 - 3570.000	1238.666				

Table 6.2.1.16
AOC 654
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref
Toluene	UG/KG	5/ 6	900.00 - 900.00	2.800 - 10.000	4.720	1600000.0000			
Vanadium	MG/KG	6/ 6		7.400 - 29.400	17.300	55.0000		77.380	
Xylene (total)	UG/KG	1/ 6	6.00 - 900.00	44.700 - 44.700	44.700	16000000.0000			
Zinc	MG/KG	6/ 6		13.000 - 81.800	44.000	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water
- l gamma-BHC (Lindane) used as surrogate

Table 6.2.1.17
SWMU 9 (includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Acenaphthene	UG/L	7/ 21	10.00 -	440.00	2.900 -	20.000	9.571	220.0000			
Acetone	UG/L	2/ 21	10.00 -	210.00	11.700 -	44.600	28.150	370.0000			
Aluminum	UG/L	4/ 21	14.00 -	140.00	162.000 -	1050.000	667.250	3700.0000			
* Antimony	UG/L	1/ 21	11.50 -	16.00	18.800 -	18.800	18.800	1.5000	1		
Arsenic	UG/L	8/ 21	1.40 -	55.80	1.300 -	11.500	4.487	0.0380	8	27.990	
* Azobenzene	UG/L	1/ 21	10.00 -	440.00	2.600 -	2.600	2.600	0.6100	1		
* Barium	UG/L	16/ 21	14.50 -	354.00	43.600 -	1200.000	365.737	260.0000	8	323.000	7
* Benzene	UG/L	11/ 21	5.00 -	5.00	1.800 -	180.000	20.381	0.3460	11		
* Benzidine	UG/L	1/ 21	51.00 -	2200.00	54.000 -	54.000	54.000	0.0003	1		
Benzoic acid	UG/L	5/ 21	51.00 -	2200.00	21.000 -	69.000	50.600	15000.0000			
2-Butanone (MEK)	UG/L	1/ 21	10.00 -	210.00	10.600 -	10.600	10.600	2200.0000			
Cadmium	UG/L	1/ 21	1.20 -	2.10	1.200 -	1.200	1.200	1.8000			
Calcium	UG/L	21/ 21			17900.000 -	473000.000	205242.857				
* Carbon disulfide	UG/L	2/ 21	5.00 -	42.00	21.100 -	80.500	50.800	2.1000	2		
* Chlorobenzene	UG/L	9/ 21	5.00 -	5.00	9.000 -	1300.000	170.555	3.9000	9		
Chloroethane	UG/L	1/ 21	5.00 -	42.00	7.000 -	7.000	7.000	860.0000			
* bis(2-Chloroethyl)ether	UG/L	1/ 21	10.00 -	11.00	140.000 -	140.000	140.000	0.0092	1		
4-Chloro-3-methylphenol	UG/L	2/ 21	10.00 -	440.00	2.800 -	3.100	2.950				
2-Chlorophenol	UG/L	1/ 21	10.00 -	440.00	5.600 -	5.600	5.600	18.0000			
* Chromium	UG/L	3/ 21	3.10 -	4.30	4.500 -	1460.000	489.933	18.0000	1		
Cobalt	UG/L	3/ 21	2.10 -	2.40	2.400 -	2.800	2.533	220.0000			
* Copper	UG/L	2/ 21	2.90 -	92.60	6.400 -	190.000	98.200	140.0000	1		
4,4'-DDT	UG/L	1/ 21	0.10 -	0.10	0.060 -	0.060	0.060	0.2000			
Dibenzofuran	UG/L	4/ 21	10.00 -	440.00	1.200 -	7.500	3.975	15.0000			
Di-n-butylphthalate	UG/L	2/ 21	10.00 -	440.00	2.700 -	3.400	3.050	370.0000			
1,2-Dichlorobenzene	UG/L	1/ 21	10.00 -	440.00	4.900 -	4.900	4.900	37.0000			
* 1,4-Dichlorobenzene	UG/L	4/ 21	10.00 -	440.00	3.100 -	7.500	5.300	0.4400	4		
* 1,2-Dichloroethane	UG/L	1/ 21	5.00 -	42.00	59.000 -	59.000	59.000	0.1200	1		
* 1,2-Dichloroethene (total)	UG/L	1/ 21	5.00 -	42.00	86.000 -	86.000	86.000	5.5000	1		
Diethylphthalate	UG/L	1/ 21	10.00 -	440.00	3.050 -	3.050	3.050				
* 2,4-Dimethylphenol	UG/L	4/ 21	10.00 -	11.00	6.633 -	1700.000	445.158	73.0000	1		
* Dioxin (TCDD TEQ)	PG/L	4/ 4			1.585 -	2.798	2.152	0.5000	4		
1234789-HpCDF	PG/L	1/ 4	1.34 -	8.94	1.361 -	1.361	1.361				
1234678-HpCDF	PG/L	2/ 4	3.30 -	5.54	2.699 -	4.356	3.528				

Table 6.2.1.17
SWMU 9 (includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
123678-HxCDD	PG/L	1/ 4	3.11 - 10.33	1.835 - 1.835	1.835				
123789-HxCDD	PG/L	2/ 4	3.53 - 10.33	1.754 - 2.129	1.941				
123678-HxCDF	PG/L	1/ 4	1.07 - 3.05	1.733 - 1.733	1.733				
123478-HxCDF	PG/L	1/ 4	1.27 - 2.27	2.336 - 2.336	2.336				
123789-HxCDF	PG/L	1/ 4	1.04 - 4.24	1.760 - 1.760	1.760				
OCDD	PG/L	2/ 4	11.89 - 42.90	9.190 - 20.047	14.619				
12378-PeCDD	PG/L	1/ 4	2.79 - 4.65	2.534 - 2.534	2.534				
23478-PeCDF	PG/L	2/ 4	2.51 - 3.31	1.322 - 1.894	1.608				
12378-PeCDF	PG/L	1/ 4	1.52 - 3.06	1.776 - 1.776	1.776				
2378-TCDF	PG/L	1/ 4	1.76 - 3.73	1.757 - 1.757	1.757				
Diphenylamine	UG/L	1/ 4	10.00 - 10.00	9.600 - 9.600	9.600	91.0000			
* Ethylbenzene	UG/L	4/ 21	5.00 - 5.00	3.200 - 150.000	76.800	130.0000	1		
* bis(2-Ethylhexyl)phthalate	UG/L	2/ 21	10.00 - 440.00	2.400 - 5.200	3.800	4.8000	1		
Fluoranthene	UG/L	2/ 21	10.00 - 440.00	2.700 - 3.900	3.300	150.0000			
Fluorene	UG/L	5/ 21	10.00 - 440.00	2.300 - 7.500	4.600	150.0000			
* Hexachlorocyclopentadiene	UG/L	1/ 21	10.00 - 440.00	11.000 - 11.000	11.000	0.0150	1		
Iron	UG/L	19/ 21	129.00 - 283.00	743.000 - 57300.000	21671.789				
* Lead	UG/L	9/ 21	1.00 - 6.00	2.400 - 52.600	14.355	15.0000	3	4.700	6
Magnesium	UG/L	21/ 21		3910.000 - 446000.000	148046.666				
Manganese	UG/L	21/ 21		15.300 - 1700.000	507.957	18.0000	20	3391.000	
Mercury	UG/L	1/ 21	0.10 - 0.10	0.550 - 0.550	0.550	1.1000			
4-Methyl-2-Pentanone (MIBK)	UG/L	1/ 21	10.00 - 210.00	2.800 - 2.800	2.800	180.0000			
2-Methylnaphthalene	UG/L	5/ 21	10.00 - 440.00	2.200 - 7.700	4.740	150.0000			
* 2-Methylphenol	UG/L	3/ 21	10.00 - 11.00	3.900 - 270.000	92.833	180.0000	1		
* 4-Methylphenol	UG/L	4/ 21	10.00 - 11.00	2.100 - 4400.000	1108.125	18.0000	2		
Naphthalene	UG/L	7/ 21	10.00 - 440.00	2.200 - 9.900	6.457	150.0000			
N-Nitrosodiphenylamine	UG/L	1/ 21	10.00 - 440.00	3.400 - 3.400	3.400	14.0000			
* Pentachlorophenol	UG/L	3/ 21	10.00 - 440.00	11.000 - 24.000	15.333	0.6000	3		
Phenanthrene	UG/L	5/ 21	10.00 - 440.00	2.600 - 9.800	4.820	150.0000			
Phenol	UG/L	3/ 21	10.00 - 440.00	6.700 - 51.766	21.988	2200.0000			
Potassium	UG/L	21/ 21		3400.000 - 130000.000	63014.285				
Selenium	UG/L	6/ 21	0.90 - 3.30	0.900 - 2.100	1.233	18.0000		3.150	
Silver	UG/L	1/ 21	2.00 - 3.40	4.400 - 4.400	4.400	18.0000			
Sodium	UG/L	21/ 21		5740.000 - 4000000.000	1389225.714				

Table 6.2.1.17
SWMU 9 (includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
2,4,5-T	UG/L	1/ 4	0.50 -	0.50	0.560 -	0.560	0.560	37.0000			
Thallium	UG/L	5/ 21	1.00 -	5.80	1.000 -	6.400	2.880	0.2900	5	7.660	
Toluene	UG/L	3/ 21	5.00 -	42.00	1.500 -	37.000	17.166	75.0000			
* Vanadium	UG/L	9/ 21	3.10 -	9.60	3.300 -	101.000	16.911	26.0000	1		
* Vinyl chloride	UG/L	1/ 21	10.00 -	83.00	720.000 -	720.000	720.000	0.0190	1		
Xylene (total)	UG/L	6/ 21	5.00 -	42.00	3.000 -	600.000	179.316	1200.0000			
Zinc	UG/L	2/ 21	3.50 -	109.00	19.600 -	19.800	19.700	1100.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.1.18
SWMU 9 (Includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/L	3/ 17	11.00 -	22.00	3.400 -	16.000	8.333	220.0000			
Acetone	UG/L	2/ 17	25.00 -	83.00	22.000 -	230.000	126.000	370.0000			
Aluminum	UG/L	3/ 17	14.30 -	193.00	440.000 -	1020.000	774.666	3700.0000			
* Arsenic	UG/L	9/ 17	2.70 -	4.10	3.800 -	75.000	20.911	0.0380	9	27.990	2
* Barium	UG/L	10/ 17	21.70 -	146.00	178.500 -	1410.000	450.250	260.0000	8	323.000	5
* Benzene	UG/L	6/ 17	5.00 -	5.00	2.600 -	85.000	18.933	0.3460	6		
* Beryllium	UG/L	1/ 17	0.30 -	1.20	1.400 -	1.400	1.400	0.0160	1		
Butylbenzylphthalate	UG/L	1/ 17	11.00 -	22.00	2.900 -	2.900	2.900	730.0000			
* Cadmium	UG/L	4/ 17	1.20 -	1.20	1.300 -	1.800	1.600	1.8000	1		
Calcium	UG/L	17/ 17			15500.000 -	428000.000	209400.000				
* Chlorobenzene	UG/L	6/ 17	5.00 -	5.00	2.100 -	520.000	102.183	3.9000	5		
Chloroethane	UG/L	1/ 17	5.00 -	17.00	6.000 -	6.000	6.000	860.0000			
2-Chlorophenol	UG/L	1/ 17	11.00 -	22.00	8.600 -	8.600	8.600	18.0000			
Cobalt	UG/L	1/ 17	2.10 -	8.40	2.600 -	2.600	2.600	220.0000			
* Copper	UG/L	2/ 17	2.90 -	13.40	7.200 -	154.000	80.600	140.0000	1		
4,4'-DDD	UG/L	1/ 17	0.10 -	0.10	0.100 -	0.100	0.100	0.2800			
4,4'-DDE	UG/L	1/ 17	0.06 -	0.06	0.030 -	0.030	0.030	0.2000			
Dibenzofuran	UG/L	1/ 17	11.00 -	22.00	4.700 -	4.700	4.700	15.0000			
1,2-Dichlorobenzene	UG/L	1/ 17	11.00 -	22.00	3.550 -	3.550	3.550	37.0000			
* 1,4-Dichlorobenzene	UG/L	2/ 17	11.00 -	22.00	5.600 -	9.050	7.325	0.4400	2		
* 1,2-Dichloroethane	UG/L	1/ 17	5.00 -	17.00	58.000 -	58.000	58.000	0.1200	1		
* 1,2-Dichloroethene (total)	UG/L	1/ 17	5.00 -	17.00	160.000 -	160.000	160.000	5.5000	1		
* 2,4-Dimethylphenol	UG/L	3/ 17	11.00 -	12.00	16.000 -	405.000	157.500	73.0000	1		
Endosulfan I	UG/L	1/ 17	0.06 -	0.06	0.070 -	0.070	0.070	22.0000			
Ethylbenzene	UG/L	3/ 17	5.00 -	5.00	20.500 -	77.500	56.333	130.0000			
Fluoranthene	UG/L	1/ 17	11.00 -	22.00	2.500 -	2.500	2.500	150.0000			
* Hexachlorobenzene	UG/L	1/ 17	11.00 -	22.00	74.000 -	74.000	74.000	0.0066	1		
* Hexachlorobutadiene	UG/L	1/ 17	11.00 -	22.00	2.800 -	2.800	2.800	0.1200	1		
* Hexachloroethane	UG/L	1/ 17	11.00 -	22.00	2.700 -	2.700	2.700	0.6100	1		
Iron	UG/L	17/ 17			172.000 -	71900.000	29065.941				
* Lead	UG/L	8/ 17	1.90 -	3.10	1.900 -	33.500	7.175	15.0000	1	4.700	2
Magnesium	UG/L	17/ 17			5280.000 -	655000.000	193983.137				
Manganese	UG/L	17/ 17			13.600 -	1990.000	589.143	18.0000	16	3391.000	
Mercury	UG/L	1/ 17	0.10 -	0.10	0.210 -	0.210	0.210	1.1000			

Table 6.2.1.18
SWMU 9 (Includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Shallow Groundwater, Sampling Round 02

	Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
	4-Methyl-2-Pentanone (MIBK)	UG/L	1/ 17	25.00 -	83.00	10.000 -	10.000	10.000	180.0000			
*	Methylene chloride	UG/L	1/ 17	9.00 -	33.00	130.000 -	130.000	130.000	4.1000	1		
	2-Methylnaphthalene	UG/L	2/ 17	11.00 -	22.00	3.050 -	5.000	4.025	150.0000i			
	2-Methylphenol	UG/L	3/ 17	11.00 -	12.00	3.300 -	42.000	16.333	180.0000			
*	4-Methylphenol	UG/L	1/ 17	11.00 -	13.00	820.000 -	820.000	820.000	18.0000	1		
	Naphthalene	UG/L	3/ 17	11.00 -	22.00	2.500 -	5.800	4.216	150.0000			
	Phenol	UG/L	2/ 17	11.00 -	22.00	4.900 -	6.300	5.600	2200.0000			
	Potassium	UG/L	16/ 17	4330.00 -	4330.00	15200.000 -	146000.000	72337.500				
	Selenium	UG/L	1/ 17	2.70 -	2.70	2.800 -	2.800	2.800	18.0000		3.150	
	Sodium	UG/L	17/ 17			24400.000 -	5460000.000	1624700.000				
	Toluene	UG/L	2/ 17	5.00 -	17.00	7.000 -	27.000	17.000	75.0000			
*	Trichloroethene	UG/L	1/ 17	5.00 -	17.00	9.000 -	9.000	9.000	1.6000	1		
	Trichlorofluoromethane	UG/L	1/ 17	5.00 -	17.00	52.000 -	52.000	52.000	130.0000			
*	Vanadium	UG/L	1/ 17	2.40 -	17.20	67.900 -	67.900	67.900	26.0000	1		
*	Vinyl chloride	UG/L	1/ 17	10.00 -	33.00	415.000 -	415.000	415.000	0.0190	1		
	Xylene (total)	UG/L	4/ 17	5.00 -	5.00	8.000 -	470.000	160.000	1200.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water

Table 6.2.1.19
SWMU 9 (includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 664)
Deep Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref
Acetone	UG/L	1/ 8	25.00 - 25.00	25.000 - 25.000	25.000	370.0000			
Aluminum	UG/L	3/ 8	14.00 - 481.00	182.000 - 1580.000	710.333	3700.0000		723.000	1
Arsenic	UG/L	4/ 8	3.80 - 7.20	2.300 - 4.800	3.925	0.0380	4	14.980	
Barium	UG/L	5/ 8	22.50 - 27.80	59.600 - 176.000	90.760	260.0000		236.900	
Benzoic acid	UG/L	1/ 8	52.00 - 57.00	2.300 - 2.300	2.300	15000.0000			
* Cadmium	UG/L	1/ 8	2.10 - 2.10	2.200 - 2.200	2.200	1.8000	1		
Calcium	UG/L	8/ 8		92200.000 - 344000.000	155300.000				
* Carbon disulfide	UG/L	1/ 8	5.00 - 5.00	61.000 - 61.000	61.000	2.1000	1		
* Chloroform	UG/L	1/ 8	5.00 - 5.00	2.400 - 2.400	2.400	0.1500	1		
* Chromium	UG/L	1/ 8	4.30 - 4.30	18.100 - 18.100	18.100	18.0000	1		
Cobalt	UG/L	2/ 8	2.40 - 2.40	2.400 - 3.000	2.700	220.0000		3.170	
Cyanide	MG/L	1/ 8	0.01 - 0.02	0.050 - 0.050	0.050	73.0000			
Di-n-butylphthalate	UG/L	1/ 8	10.00 - 11.00	3.000 - 3.000	3.000	370.0000			
Iron	UG/L	8/ 8		1010.000 - 8590.000	4943.750				
Lead	UG/L	4/ 8	1.00 - 1.40	2.200 - 6.900	4.425	15.0000j		4.260	2
Magnesium	UG/L	8/ 8		559000.000 - 820000.000	653625.000				
* Manganese	UG/L	8/ 8		26.600 - 805.000	352.862	18.0000	8	776.200	1
Potassium	UG/L	8/ 8		153000.000 - 195000.000	176375.000				
Selenium	UG/L	1/ 8	0.90 - 3.30	1.000 - 1.000	1.000	18.0000		2.100	
Sodium	UG/L	8/ 8		4370000.000 - 6380000.000	5408750.000				
* Thallium	UG/L	1/ 8	2.00 - 10.00	160.000 - 160.000	160.000	0.2900	1		
Vanadium	UG/L	4/ 8	3.10 - 6.40	4.500 - 12.200	7.675	26.0000		9.290	1

Notes:

* Retained as a chemical of potential concern
a USEPA Region III Residential Risk-Based Screening Value, March 1994
j Based on proposed action level for soil and treatment technique action level for water

Table 6.2.1.20
SWMU 9 (includes SWMUs 19, 20, 121 and AOCs 649, 650, 651, 654)
Deep Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bound	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num over Screen	Reference Conc.	Num over Ref.
Arsenic	UG/L	1/ 8	2.70 - 2.70	4.100 - 4.100	4.100	0.0380	1	14.980	
• Cadmium	UG/L	3/ 8	1.20 - 1.20	2.600 - 3.200	2.833	1.8000	3		
Calcium	UG/L	8/ 8		116000.000 - 453000.000	195875.000				
Iron	UG/L	7/ 8	176.00 - 176.00	780.000 - 13600.000	6832.857				
Magnesium	UG/L	8/ 8		710000.000 - 873000.000	792250.000				
• Manganese	UG/L	8/ 8		16.600 - 1270.000	566.450	18.0000	7	776.200	3
Potassium	UG/L	8/ 8		205000.000 - 241000.000	220875.000				
Sodium	UG/L	8/ 8		5730000.000 - 7550000.000	6355000.000				

Notes:

- • Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.1.21
Exposure Pathways Summary — Combined SWMU 9
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified in surface soil at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 9.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 9.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 9.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 9.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified in surface soil at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes (First and Second Quarters)	CPSSs were greater than RBC and Reference concentrations.

Table 6.2.1.21
Exposure Pathways Summary — Combined SWMU 9
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified in surface soil at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 9.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 9.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 9.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 9.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified in surface soil at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes (First and Second Quarters)	CPSSs were greater than RBC and Reference concentrations.

Table 6.2.1.21
Exposure Pathways Summary — Combined SWMU 9
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes (First and Second Quarters)	VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Deep groundwater, Ingestion of contaminants during potable or general use	Yes (First and Second Quarters)	CPSSs were greater than RBC and Reference concentrations.
	Deep groundwater, Inhalation of volatilized contaminants during domestic use	Yes (First Quarter Only)	VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs for first quarter deep groundwater. No VOCs were identified as COPCs based on second quarter groundwater data.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.1.22
Statistical Analysis of COPCs
Surface Soils at SWMU 019
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed SD	Natural Log Transformed mean	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Antimony	17	1.61	0.33	3.709	22.623	436	22.62	UCL used	NA	22.62
Aroclor-1254	17	1.15	3.29	2.923	0.121	2.3	0.12	UCL used	NA	0.12
Aroclor-1260	17	1.29	4.17	3.152	0.411	0.56	0.41	UCL used	NA	0.41
Arsenic	17	0.88	1.82	2.509	15.786	22.1	15.79	UCL used	NA	15.79
Benzo(a)pyrene Equivalents	17	0.86	5.14	2.481	0.421	0.8084	0.421	UCL used	1	0.421
Beryllium	17	0.81	-0.7	2.412	1.123	3.0	1.12	UCL used	NA	1.12
Copper	17	2.03	5.45	4.48	17750	3040	3040	MAX used	NA	3040
Lead	17	1.97	4.67	4.367	6383	6170	6170	MAX used	NA	6170
Nickel	17	1.46	3.24	3.443	260	282	260.48	UCL used	NA	260.48
Zinc	17	1.67	5.49	3.817	4808	2800	2800	MAX used	NA	2800

NOTES:

mean	arithmetic mean of the logtransformed data
n	number of samples analyzed
SD	standard deviation for a sample of data
H-stat	"H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA	not applicable
EPC	exposure point concentration
UCL	95 percentile upper confidence level mean
MAX	maximum reported concentration

Table 6.2.1.23
Statistical Analysis of COPCs
Surface Soils at SWMU 020
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed SD	Natural Log Transformed mean	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Benzo(a)pyrene Equivalents	11	0.82	5.68	2.676	0.821	1.12	0.821	UCL used	1	0.821

NOTES:

- mean arithmetic mean of the logtransformed data
- n number of samples analyzed
- SD standard deviation for a sample of data
- H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
- NA not applicable
- EPC exposure point concentration
- UCL 95 percentile upper confidence level mean
- MAX maximum reported concentration

Table 6.2.1.24
Statistical Analysis of COPCs
Surface Soils at SWMU 121
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed SD	mean	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Antimony	16	0.99	1	2.699	8.85	9.45	8.85	UCL used	NA	8.85
Aroclor-1248	16	0.83	3.52	2.463	0.08	0.16	0.08	UCL used	NA	0.08
Aroclor-1254	16	1.74	4.34	4.002	2.1	4.3	2.10	UCL used	NA	2.10
Aroclor-1260	16	1.25	4.78	3.123	0.7	1.1	0.71	UCL used	NA	0.71
Arsenic	16	0.82	1.7	2.449	12.9	18.7	12.87	UCL used	NA	12.87
Benzo(a)pyrene Equivalents	16	1.16	5.62	2.976	1.32	2.54	1.32	UCL used	1	1.32
Beryllium	16	1.11	0.53	2.894	7.2	14.6	7.21	UCL used	NA	7.21
Chromium	16	0.83	3.63	2.463	90	210	90	UCL used	NA	90
Copper	16	1.42	6.13	3.421	4414	4060	4060	MAX used	NA	4060
Lead	16	1.08	5.77	2.845	1270	2770	1270	UCL used	NA	1270
Manganese	16	0.95	5.23	2.638	560	1020	560	UCL used	NA	560
Mercury	16	1.37	-0.7	3.334	4.1	3.5	3.5	MAX used	NA	3.5
Nickel	16	1.35	4.75	3.299	908	995	908	UCL used	NA	908
Thallium	16	0.75	-0.93	2.354	0.8	2.7	0.8	UCL used	NA	0.8
Vanadium	16	1.23	3.83	3.09	262	470	262	UCL used	NA	262
Zinc	16	1.33	7.31	3.263	11105	15100	11105	UCL used	NA	11105

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term
NA not applicable
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.1.25
Statistical Analysis of COPCs
Surface Soils at AOC 649
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Benzo(a)pyrene Equivalents	10	4.83	0.49	2.207	0.202454	0.403288	0.202	UCL used	1	0.202
Mercury	10	-2.8	1.98	5.348	14.72913	6.9	6.900	MAX used	NA	6.900

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
TEF toxic equivalency factor
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.1.26
Statistical Analysis of COPCs
SWMU 9 Shallow Groundwater - First Quarter
Naval Base Charleston Zone H
Charleston, South Carolina

		Natural Log Transformed			UCL	MAX	EPC			Adjusted EPC
COPC	n	mean	SD	H-stat	(mg/L)	(mg/L)	(mg/L)		TEF	(mg/kg)
Azobenzene	21	0.3	0.15	1.747	0.001447	0.0026	0.001447	UCL used	NA	0.001447
Chlorobenzene	21	2.06	1.66	3.572	0.117182	1.3	0.117182	UCL used	NA	0.117182
Chromium (trivalent)	21	1.11	1.44	3.218	0.024117	1.46	0.024117	UCL used	NA	0.024117
1,4-Dichlorobenzene	21	0.66	0.5	1.989	0.002738	0.0075	0.002738	UCL used	NA	0.002738
1,2-Dichloroethane	21	1.17	0.81	2.230	0.006808	0.059	0.006808	UCL used	NA	0.006808
1,2-Dichloroethene (total)	21	1.19	0.88	2.407	0.007774	0.086	0.007774	UCL used	NA	0.007774
Antimony	21	2.07	0.23	1.790	0.008922	0.0188	0.008922	UCL used	NA	0.008922
Barium	21	5.13	1.25	2.963	0.835686	1.2	0.835686	UCL used	NA	0.835686
Benzene	21	0.82	1.29	2.985	0.012343	0.18	0.012343	UCL used	NA	0.012343
Benzidine	21	3.32	0.16	1.751	0.029829	0.054	0.029829	UCL used	NA	0.029829
Carbon disulfide	21	1.36	0.99	2.551	0.01187	0.0805	0.01187	UCL used	NA	0.01187
BEHP	21	0.29	0.35	1.869	0.001645	0.0052	0.001645	UCL used	NA	0.001645
Copper	21	1.17	1.28	2.970	0.017101	0.19	0.017101	UCL used	NA	0.017101
2,4-Dimethylphenol	21	1.74	1.48	3.280	0.050433	1.7	0.050433	UCL used	NA	0.050433
2,3,7,8-TCDD equivalents	4	0.73	0.31	NA	NA	2.8E-09	2.798E-09	MAX used	NA	2.8E-09
Ethylbenzene	21	1.08	1.46	3.249	0.02469	0.15	0.02469	UCL used	NA	0.02469
bis(2-Chloroethyl)ether	21	1.83	0.72	2.214	0.011538	0.14	0.011538	UCL used	NA	0.011538
Hexachlorocyclopentadiene	21	1.71	0.16	1.751	0.005962	0.011	0.005962	UCL used	NA	0.005962
Lead	21	1.71	1.39	3.140	0.016812	0.0526	0.016812	UCL used	NA	0.016812
2-Methylphenol	21	0.98	1.08	2.679	0.009117	0.27	0.009117	UCL used	NA	0.009117
4-Methylphenol	21	0.69	1.91	3.989	0.06788	4.4	0.06788	UCL used	NA	0.06788
Pentachlorophenol	21	1.83	0.38	1.830	0.001891	0.024	0.001891	UCL used	NA	0.001891
Vanadium	21	1.37	0.97	2.624	0.010891	0.101	0.010891	UCL used	NA	0.010891
Vinyl chloride	21	1.95	1.16	2.794	0.02843	0.72	0.02843	UCL used	NA	0.02843

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
TEF toxic equivalency factor
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.1.27
Statistical Analysis of COPCs
SWMU 9 Shallow Groundwater - Second Quarter
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/L)	MAX (mg/L)	EPC (mg/L)		TEF	Adjusted EPC (mg/kg)
Chlorobenzene	17	1.15000	1.84000	4.127	0.11457	0.52	0.11457	UCL used	NA	0.11457
1,4-Dichlorobenzene	17	1.14000	0.32000	1.882	0.003826	0.00905	0.003826	UCL used	NA	0.003826
1,2-Dichloroethane	17	1.17000	0.80000	2.398	0.007167	0.058	0.007167	UCL used	NA	0.007167
1,2-Dichloroethene (total)	17	1.23000	1.03000	2.732	0.01175	0.16	0.01175	UCL used	NA	0.01175
Methylene chloride	17	1.87000	0.83000	2.439	0.01519	0.13	0.0151897	UCL used	NA	0.01519
Trichloroethene	17	1.03000	0.33000	1.890	0.003457	0.009	0.003457	UCL used	NA	0.003457
Beryllium	17	-1.60000	0.68000	2.244	0.000373	0.0014	0.0003726	UCL used	NA	0.000373
Arsenic	17	1.51000	1.35000	3.254	0.033725	0.076	0.033725	UCL used	NA	0.033725
Barium	17	4.96000	1.34000	3.237	1.03515	1.41	1.03515	UCL used	NA	1.03515
Benzene	17	0.91000	1.14000	2.907	0.010896	0.085	0.010896	UCL used	NA	0.010896
Cadmium	17	-0.28000	1.43000	1.975	0.001025	0.0018	0.001025	UCL used	NA	0.001025
Copper	17	1.00000	1.22000	3.035	0.014438	0.154	0.014438	UCL used	NA	0.014438
2,4-Dimethylphenol	17	2.21000	1.13000	2.891	0.039067	0.405	0.039067	UCL used	NA	0.039067
Hexachlorobenzene	17	1.96000	0.62000	2.173	0.012049	0.074	0.012049	UCL used	NA	0.012049
Hexachlorobutadiene	17	0.38000	0.17000	1.779	0.0016	0.0028	0.0016	UCL used	NA	0.0016
Hexachloroethane	17	0.34000	0.17000	1.779	0.001537	0.0027	0.001537	UCL used	NA	0.001537
Lead	17	0.69000	0.97000	2.640	0.006053	0.0335	0.006053	UCL used	NA	0.006053
4-Methylphenol	17	2.07000	1.20000	3.003	0.04008	0.82	0.04008	UCL used	NA	0.04008
Vanadium	17	1.14000	0.96000	2.625	0.009037	0.0679	0.009037	UCL used	NA	0.009037
Vinyl chloride	17	1.94000	1.09000	2.828	0.027237	0.415	0.027237	UCL used	NA	0.027237

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
TEF toxic equivalency factor
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.1.28
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 019
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	NA	22.62	3.10E-05	2.89E-04	3.54E-05	1.11E-05	3.95E-06
Aroclor-1254	NA	0.12	1.65E-07	1.54E-06	1.89E-07	5.90E-08	2.11E-08
Aroclor-1260	NA	0.41	5.63E-07	5.25E-06	6.43E-07	2.01E-07	7.18E-08
Arsenic	NA	15.79	2.16E-05	2.02E-04	2.47E-05	7.72E-06	2.76E-06
Benzo(a)pyrene Equivalents	1	0.42	5.77E-07	5.39E-06	6.59E-07	2.06E-07	7.36E-08
Beryllium	NA	1.12	1.54E-06	1.44E-05	1.76E-06	5.50E-07	1.96E-07
Copper	NA	3040	4.16E-03	3.89E-02	4.76E-03	1.49E-03	5.31E-04
Lead	NA	6170	8.45E-03	7.89E-02	9.66E-03	3.02E-03	1.08E-03
Nickel	NA	260.48	3.57E-04	3.33E-03	4.08E-04	1.27E-04	4.55E-05
Zinc	NA	2800	3.84E-03	3.58E-02	4.38E-03	1.37E-03	4.89E-04

NOTES:

lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- exposure point concentrations were adjusted to equivalent concentrations by their corresponding TEF

Table 6.2.1.29
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 019
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	NA	22.62	0.001	1.27E-06	2.89E-06	6.84E-07	9.08E-07	3.24E-07
Aroclor-1254	NA	0.12	0.01	6.77E-08	1.54E-07	3.64E-08	4.83E-08	1.73E-08
Aroclor-1260	NA	0.41	0.01	2.31E-07	5.25E-07	1.24E-07	1.65E-07	5.89E-08
Arsenic	NA	15.79	0.001	8.87E-07	2.02E-06	4.77E-07	6.33E-07	2.26E-07
Benzo(a)pyrene Equivalents	1	0.42	0.01	2.37E-07	5.39E-07	1.27E-07	1.69E-07	6.04E-08
Beryllium	NA	1.12	0.001	6.31E-08	1.44E-07	3.39E-08	4.51E-08	1.61E-08
Copper	NA	3040	0.001	1.71E-04	3.89E-04	9.19E-05	1.22E-04	4.36E-05
Lead	NA	6170	0.001	3.47E-04	7.89E-04	1.86E-04	2.48E-04	8.84E-05
Nickel	NA	260.48	0.001	1.46E-05	3.33E-05	7.87E-06	1.04E-05	3.73E-06
Zinc	NA	2800	0.001	1.57E-04	3.58E-04	8.46E-05	1.12E-04	4.01E-05

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.1.30
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 020
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.821	1.12E-06	1.05E-05	1.28E-06	4.01E-07	1.43E-07

NOTES:

lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- exposure point concentrations were adjusted to equivalent concentrations by their corresponding TEF

ble 6.2.1.31
ronic Daily Intakes (CDI)
ermal Contact with Surface Soil (0-1')
VMU 020
aval Base Charleston
arleston, SC

emical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Futur Resident lwa C-CDI (mg/kg-day)	Potential Curren Worker adult H-CDI (mg/kg-day)	Potential Curren Worker adult C-CDI (mg/kg-day)
nzo(a)pyrene Equivalents	1	0.821	0.01	4.61E-07	1.52E-06	2.88E-07	3.29E-07	1.18E-07

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.1.32
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 121
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	NA	8.85	1.21E-05	1.13E-04	1.38E-05	4.33E-06	1.55E-06
Aroclor-1248	NA	0.08	1.11E-07	1.03E-06	1.27E-07	3.95E-08	1.41E-08
Aroclor-1254	NA	2.10	2.88E-06	2.69E-05	3.29E-06	1.03E-06	3.68E-07
Aroclor-1260	NA	0.71	9.76E-07	9.11E-06	1.12E-06	3.49E-07	1.25E-07
Arsenic	NA	12.87	1.76E-05	1.65E-04	2.01E-05	6.30E-06	2.25E-06
Benzo(a)pyrene Equivalents	1	1.32	1.81E-06	1.69E-05	2.06E-06	6.45E-07	2.30E-07
Beryllium	NA	7.21	9.88E-06	9.22E-05	1.13E-05	3.53E-06	1.26E-06
Chromium	NA	90.22	1.24E-04	1.15E-03	1.41E-04	4.41E-05	1.58E-05
Copper	NA	4060.00	5.56E-03	5.19E-02	6.36E-03	1.99E-03	7.09E-04
Lead	NA	1269.67	1.74E-03	1.62E-02	1.99E-03	6.21E-04	2.22E-04
Manganese	NA	560.27	7.67E-04	7.16E-03	8.77E-04	2.74E-04	9.79E-05
Mercury	NA	3.50	4.79E-06	4.47E-05	5.48E-06	1.71E-06	6.12E-07
Nickel	NA	907.79	1.24E-03	1.16E-02	1.42E-03	4.44E-04	1.59E-04
Thallium	NA	0.82	1.13E-06	1.05E-05	1.29E-06	4.03E-07	1.44E-07
Vanadium	NA	261.88	3.59E-04	3.35E-03	4.10E-04	1.28E-04	4.58E-05
Zinc	NA	11104.72	1.52E-02	1.42E-01	1.74E-02	5.43E-03	1.94E-03

NOTES:

lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- exposure point concentrations were adjusted to equivalent concentrations by their corresponding TEF

Table 6.2.1.33
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 121
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	NA	8.85	0.001	4.97E-07	1.64E-06	3.11E-07	3.55E-07	1.27E-07
Aroclor-1248	NA	0.08	0.01	4.54E-08	1.50E-07	2.84E-08	3.24E-08	1.16E-08
Aroclor-1254	NA	2.10	0.01	1.18E-06	3.90E-06	7.40E-07	8.44E-07	3.02E-07
Aroclor-1260	NA	0.71	0.01	4.00E-07	1.32E-06	2.51E-07	2.86E-07	1.02E-07
Arsenic	NA	12.87	0.001	7.23E-07	2.39E-06	4.52E-07	5.16E-07	1.84E-07
Benzo(a)pyrene Equivalents	1	1.32	0.01	7.40E-07	2.44E-06	4.63E-07	5.29E-07	1.89E-07
Beryllium	NA	7.21	0.001	4.05E-07	1.34E-06	2.53E-07	2.89E-07	1.03E-07
Chromium	NA	90.22	0.001	5.07E-06	1.67E-05	3.17E-06	3.62E-06	1.29E-06
Copper	NA	4060.00	0.001	2.28E-04	7.53E-04	1.43E-04	1.63E-04	5.82E-05
Lead	NA	1269.67	0.001	7.13E-05	2.35E-04	4.46E-05	5.09E-05	1.82E-05
Manganese	NA	560.27	0.001	3.15E-05	1.04E-04	1.97E-05	2.25E-05	8.03E-06
Mercury	NA	3.50	0.001	1.97E-07	6.49E-07	1.23E-07	1.40E-07	5.01E-08
Nickel	NA	907.79	0.001	5.10E-05	1.68E-04	3.19E-05	3.64E-05	1.30E-05
Thallium	NA	0.82	0.001	4.63E-08	1.53E-07	2.90E-08	3.31E-08	1.18E-08
Vanadium	NA	261.88	0.001	1.47E-05	4.86E-05	9.21E-06	1.05E-05	3.75E-06
Zinc	NA	11104.72	0.001	6.24E-04	2.06E-03	3.90E-04	4.45E-04	1.59E-04

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.1.34
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 649
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.202	2.77E-07	2.59E-06	3.17E-07	9.90E-08	3.54E-08
Mercury	NA	6.9	9.45E-06	8.82E-05	1.08E-05	3.38E-06	1.21E-06

NOTES:

TEF	toxic equivalency factor relative to Benzo(a)pyrene
lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
-	exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.1.35
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 649
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.20	0.01	1.14E-07	3.75E-07	7.12E-08	8.12E-08	2.90E-08
Mercury	NA	6.90	0.001	3.88E-07	1.28E-06	2.43E-07	2.77E-07	9.89E-08

NOTES:

TEF Toxic Equivalency Factor relative to benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.1.36
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 650
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	NA	0.41	5.58E-07	5.20E-06	6.37E-07	1.99E-07	7.11E-08
Benzo(a)pyrene Equivalents	1	3.07	4.21E-06	3.93E-05	4.81E-06	1.50E-06	5.37E-07
Copper	NA	357	4.89E-04	4.56E-03	5.59E-04	1.75E-04	6.24E-05

NOTES:

lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
-	exposure point concentrations were adjusted to equivalent concentrations by their corresponding TEF

Table 6.2.1.37
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 650
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	NA	0.41	0.01	2.29E-07	7.66E-07	1.43E-07	1.63E-07	5.83E-08
Benzo(a)pyrene Equivalents	1	3.07	0.01	1.73E-06	5.70E-06	1.08E-06	1.23E-06	4.40E-07
Copper	NA	357	0.001	2.01E-05	6.62E-05	1.25E-05	1.43E-05	5.11E-06

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

ble 6.2.1.38
ronic Daily Intakes (CDI)
estion/Inhalation of COPCs in Shallow Groundwater
/MU 9 - First Quarter
val Base Charleston
arleston, SC

emical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
obenzene	0.0014	3.96E-05	9.25E-05	2.18E-05	1.42E-05	6.96E-06
orobenzene	0.117	3.21E-03	7.49E-03	1.77E-03	1.15E-03	5.64E-04
romium (trivalent)	0.0241	6.61E-04	1.54E-03	3.63E-04	2.36E-04	1.16E-04
-Dichlorobenzene	0.0027	7.50E-05	1.75E-04	4.13E-05	2.68E-05	1.32E-05
-Dichloroethane	0.0068	1.87E-04	4.35E-04	1.03E-04	6.66E-05	3.28E-05
-Dichloroethene (total)	0.0078	2.13E-04	4.97E-04	1.17E-04	7.61E-05	3.74E-05
timony	0.0089	2.44E-04	5.70E-04	1.34E-04	8.73E-05	4.29E-05
ium	0.836	2.29E-02	5.34E-02	1.26E-02	8.18E-03	4.02E-03
nzene	0.0123	3.38E-04	7.89E-04	1.86E-04	1.21E-04	5.94E-05
nzidine	0.0298	8.17E-04	1.91E-03	4.49E-04	2.92E-04	1.44E-04
rbon disulfide	0.0119	3.25E-04	7.59E-04	1.79E-04	1.16E-04	5.71E-05
HP	0.0016	4.51E-05	1.05E-04	2.48E-05	1.61E-05	7.92E-06
pper	0.0171	4.69E-04	1.09E-03	2.58E-04	1.67E-04	8.23E-05
-Dimethylphenol	0.0504	1.38E-03	3.22E-03	7.60E-04	4.93E-04	2.43E-04
,7,8-TCDD equivalents	2.798E-09	7.67E-11	1.79E-10	4.22E-11	2.74E-11	1.35E-11
ylbenzene	0.0247	6.76E-04	1.58E-03	3.72E-04	2.42E-04	1.19E-04
(2-Chloroethyl)ether	0.0115	3.16E-04	7.38E-04	1.74E-04	1.13E-04	5.55E-05
xachlorocyclopentadiene	0.0060	1.63E-04	3.81E-04	8.98E-05	5.83E-05	2.87E-05
d	0.0168	4.61E-04	1.07E-03	2.53E-04	1.65E-04	8.09E-05
lethylphenol	0.0091	2.50E-04	5.83E-04	1.37E-04	8.92E-05	4.39E-05
lethylphenol	0.0679	1.86E-03	4.34E-03	1.02E-03	6.64E-04	3.27E-04
ntachlorophenol	0.0019	5.18E-05	1.21E-04	2.85E-05	1.85E-05	9.10E-06
nadium	0.0109	2.98E-04	6.96E-04	1.64E-04	1.07E-04	5.24E-05
yl chloride	0.0284	7.79E-04	1.82E-03	4.28E-04	2.78E-04	1.37E-04

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.1.39
Chronic Daily Intakes (CDI)
Ingestion/Inhalation of COPCs in Deep Groundwater
SWMU 9 - First Quarter
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Chromium (trivalent)	0.0181	4.96E-04	1.16E-03	2.73E-04	1.77E-04	8.71E-05
Cadmium	0.0022	6.03E-05	1.41E-04	3.32E-05	2.15E-05	1.06E-05
Carbon disulfide	0.061	1.67E-03	3.90E-03	9.19E-04	5.97E-04	2.94E-04
Chloroform	0.0024	6.58E-05	1.53E-04	3.62E-05	2.35E-05	1.16E-05
Manganese	0.805	2.21E-02	5.15E-02	1.21E-02	7.88E-03	3.87E-03
Thallium	0.16	4.38E-03	1.02E-02	2.41E-03	1.57E-03	7.70E-04

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.1.40
Chronic Daily Intakes (CDI)
Ingestion/Inhalation of COPCs in Shallow Groundwater
SWMU 9 - Second Quarter
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Chlorobenzene	0.11457	3.14E-03	7.32E-03	1.73E-03	1.12E-03	5.51E-04
1,4-Dichlorobenzene	0.003826	1.05E-04	2.45E-04	5.77E-05	3.74E-05	1.84E-05
1,2-Dichloroethane	0.007167	1.96E-04	4.58E-04	1.08E-04	7.01E-05	3.45E-05
1,2-Dichloroethene (total)	0.01175	3.22E-04	7.51E-04	1.77E-04	1.15E-04	5.66E-05
Methylene chloride	0.0151897	4.16E-04	9.71E-04	2.29E-04	1.49E-04	7.31E-05
Trichloroethene	0.003457	9.47E-05	2.21E-04	5.21E-05	3.38E-05	1.66E-05
Beryllium	0.0003726	1.02E-05	2.38E-05	5.61E-06	3.65E-06	1.79E-06
Arsenic	0.033725	9.24E-04	2.16E-03	5.08E-04	3.30E-04	1.62E-04
Barium	1.03515	2.84E-02	6.62E-02	1.56E-02	1.01E-02	4.98E-03
Benzene	0.010896	2.99E-04	6.97E-04	1.64E-04	1.07E-04	5.24E-05
Cadmium	0.001025	2.81E-05	6.55E-05	1.54E-05	1.00E-05	4.93E-06
Copper	0.014438	3.96E-04	9.23E-04	2.18E-04	1.41E-04	6.95E-05
2,4-Dimethylphenol	0.039067	1.07E-03	2.50E-03	5.89E-04	3.82E-04	1.88E-04
Hexachlorobenzene	0.012049	3.30E-04	7.70E-04	1.82E-04	1.18E-04	5.80E-05
Hexachlorobutadiene	0.0016	4.38E-05	1.02E-04	2.41E-05	1.57E-05	7.70E-06
Hexachloroethane	0.001537	4.21E-05	9.83E-05	2.32E-05	1.50E-05	7.40E-06
Lead	0.006053	1.66E-04	3.87E-04	9.12E-05	5.92E-05	2.91E-05
4-Methylphenol	0.04008	1.10E-03	2.56E-03	6.04E-04	3.92E-04	1.93E-04
Vanadium	0.009037	2.48E-04	5.78E-04	1.36E-04	8.84E-05	4.35E-05
Vinyl chloride	0.027237	7.46E-04	1.74E-03	4.10E-04	2.67E-04	1.31E-04

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.1.41
Chronic Daily Intakes (CDI)
Ingestion/Inhalation of COPCs in Deep Groundwater
SWMU 9 - Second Quarter
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Cadmium	0.0032	8.77E-05	2.05E-04	4.82E-05	3.13E-05	1.54E-05
Manganese	1.27	3.48E-02	8.12E-02	1.91E-02	1.24E-02	6.11E-03

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

e 6.2.1.42 - SWMU 9
cological Database Information
Chemicals of Potential Concern
/BASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

mical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation
mony	0.0004	a	L	whole body/blood increased mor	1000	ND				ND
enic	0.0003	a	M	hyperpigmentation	3	ND				ND
oenzene	ND				ND	ND				ND
um	0.07	a	M	increased blood pressure	ND	0.000143	b	NA		ND
zene	ND				ND	0.00171	e	NA		ND
zidine	0.003	a	M	brain and liver changes	1000	ND				ND
zo(a)pyrene Equivalents	ND				ND	ND				ND
llium	0.005	a	L	microscopic organ changes	100	ND				ND
2-Chloroethyl)ether	ND				ND	ND				ND
2-Ethylhexyl)phthalate	0.02	a	M	increased liver weight	1000	ND				ND
oon disulfide	0.1	a	M	fetotoxicity	1000	0.2			fetotoxicity	
robenzene	0.02	a	M	liver changes	1000	0.00571	c			10000
roform	0.01	a	M/L	fatty cysts in liver	1000	ND				ND
omium	1	a	L	NA	100/10	ND				ND
oer	0.0371	b	NA	NA	ND	ND				ND
Dichloroethene	0.009	a	M	liver lesions	1000	ND				ND
Dichloroethane	ND				ND	0.00286	e			
Dichloroethene (total)	0.009	b	L	increased serum phosphatase	1000	ND				ND
Dichlorobenzene	ND				ND	0.229	a	M	increased liver weight	100
Dimethylphenol	0.02	a	L	CNS/blood alterations	3000	ND				ND
lbenzene	0.1	a	L	liver and kidney toxicity	1000	0.286	a		liver and kidney toxicity	1000
ichlorobenzene	0.0008	a	M	liver effects	100	ND				ND
ichlorobutadiene	0.0002	b		renal tubal regeneration		ND				ND
ichlorocyclopentadiene	0.007	a	L	forestomach lesions	1000	2E-05	a		nasal squamous metap	1000
ichloroethane	0.001	a	M	kidney degeneration	1000	ND				ND
	ND				ND	ND				ND
thylphenol	0.05	a	M	whole body decreased weight/C	1000	ND				ND
thylphenol	0.005	b		CNS/respiratory distress	1000	ND				ND
ianese (food)	0,14	a	NA	neurological effects	1	ND				ND
ianese (water)	0.005	a	NA	neurological effects	1	1.43E-05	a	M	neurological effects	1000
ury	0.0003	a	M	hand tremor and memory distur	30	ND				ND
ylene chloride	0.06	a	M	liver toxicity	100	0.857	a		liver toxicity	
il	0.02	a	M	decreased body and organ weig	300	ND				ND
Aroclor-1248	ND				ND	ND				ND
Aroclor-1254	2E-05	a	NA		ND	ND				ND
Aroclor-1260	ND				ND	ND				ND
ichlorophenol	0.03	a	M	fetotoxicity	100	ND				ND
8-TCDD	ND				ND	ND				ND
um	8E-05	a		increased SGOT (liver) increase	3000	ND				ND
oroethene	0.006	e	NA	NA	NA	ND				ND

ɔle 6.2.1.42 - SWMU 9
ɛicological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

emical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation
ıadium	0.007	a		unclear	100	ND			ND
yl chloride	ND				ND	ND			ND
c	0.3	a	M	decreased enzyme levels	3	ND			ND

NOTES:

a Integrated Risk Information System (IRIS)
b Health Effects Assessment Summary Tables (HEAST)
c HEAST alternative method
e EPA Environmental Criteria and Assessment Office - Cincinnati (provisional)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

e 6.2.1.42 - SWMU 9
cological Database Information
hemicals of Potential Concern
BASE Charleston, Zone H

Carcinogenic Toxicity Data

mical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
nony	ND		ND		D	
nic	1.5	a	15.1	a	A	various
benzene	0.11	a	0.108	a	B2	abdominal and spleen sarcoma
um	ND		ND		D	
zene	0.029	a	0.029	a	A	leukemia
zidine	230	a	235	a	A	bladder cancer
zo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
llium	4.3	a	8.4	a	B2	osteosarcoma
2-Chloroethyl)ether	1.1	a	1.16	a	ND	hepatoma
2-Ethylhexyl)phthalate	0.014	a	ND		B2	hepatoma
bon disulfide	ND		ND		D	
robenzene	ND		ND		D	Chlorobenzene
roform	0.0061	a	2.3E-05 ((ug/cm3)-1)	a	B2	
mium	ND		42	a	D	
per	ND		ND		D	
Dichloroethene	0.6	a	0.175	a	C	kidney adenosarcoma
Dichloroethane	0.091	a	0.091	a	B2	stomach sarcoma, hemangiosarcoma, mammary
Dichloroethene (total)	ND		ND		D	
Dichlorobenzene	0.024	b	ND		B2	NA
Dimethylphenol	ND		ND		D	
lbenzene	ND		ND		D	
ichlorobenzene	1.6	a	1.61	a	B2	liver, kidney and throid tumors
ichlorobutadiene	0.078	a	0.077	a	C	renal adenomas
ichlorocyclopentadiene	ND		ND		D	
ichloroethane	0.014	a	0.014	a	C	liver carcinoma
	ND		ND		B2	various
thylphenol	ND		ND		D	
thylphenol	ND		ND		D	
janese (food)	ND		ND		D	
janese (water)	ND		ND		D	
ury	ND		ND		D	
ylene chloride	0.0075	a	0.00164	a	B2	liver and lung neoplasms
l	ND		ND		D	
Aroclor-1248	7.7		ND		B2	hepatocellular carcinoma
Aroclor-1254	7.7		ND		B2	hepatocellular carcinoma
Aroclor-1260	7.7		ND		B2	hepatocellular carcinoma
ichlorophenol	0.12	a	ND		B2	multiple tumor types
8-TCDD	150000	b			B2	mutagen and teratogen
um	ND		ND		D	
oroethene	ND		0.006	e	B2	forestomach tumors in mice

ble 6.2.1.42 - SWMU 9
xicological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Carcinogenic Toxicity Data

emical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
nadium	ND		ND		D	
yl chloride	1.9	b	0.3	b	A	hepatocellular carcinoma
c	ND		ND		D	

Table 6.2.1.43
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 019
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.0004	NA	0.077	0.72	ND	0.028	ND
Aroclor-1254	2E-05	7.7	0.008	0.08	1.5E-06	0.003	1.6E-07
Aroclor-1260	NA	7.7	ND	ND	5.0E-06	ND	5.5E-07
Arsenic	0.0003	1.5	0.072	0.67	3.7E-05	0.026	4.1E-06
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	4.8E-06	ND	5.4E-07
Beryllium	0.005	4.3	0.0003	0.003	7.6E-06	0.00011	8.4E-07
Copper	0.0371	NA	0.112	1.05	ND	0.040	ND
Lead	NA	NA	ND	ND	ND	ND	ND
Nickel	0.02	NA	0.018	0.17	ND	0.006	ND
Zinc	0.3	NA	0.013	0.12	ND	0.005	ND
SUM Hazard Index/ILCR			0.3	3	6E-05	0.1	6E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.1.44
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 019
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.2	8E-05	NA	0.016	0.036	ND	0.0113	ND
Aroclor-1254	0.5	1E-05	15.4	0.0068	0.015	5.6E-07	0.0048	2.7E-07
Aroclor-1260	0.5	NA	15.4	ND	ND	1.9E-06	ND	9.1E-07
Arsenic	0.2	6E-05	7.5	0.015	0.034	3.6E-06	0.011	1.7E-06
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.9E-06	ND	8.8E-07
Beryllium	0.2	0.001	21.5	0.000063	0.00014	7.3E-07	0.000045	3.5E-07
Copper	0.2	0.00742	NA	0.02	0.05	ND	0.016	ND
Lead	0.2	NA	NA	ND	ND	ND	ND	ND
Nickel	0.2	0.004	NA	0.0037	0.0083	ND	0.0026	ND
Zinc	0.2	0.06	NA	0.0026	0.0060	ND	0.0019	ND
SUM Hazard Index/ILCR				0.07	0.2	9E-06	0.05	4E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.1.45
NAVBASE — Charleston Zone H
SWMU 19
USEPA LEAD MODEL Version 0.99d Output

AIR CONCENTRATION: 0.100 μg Pb/m³ DEFAULT

Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m³/day)	Lung Abs. (%)
5-6	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 15.00 μg Pb/L
(set equal to the USEPA Office of Water Treatment Technique AL)
WATER Consumption: Default

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (μg Pb/g)	House Dust (μg Pb/g)
5-6	200.0	200.0

Additional Dust Sources: None DEFAULT

ALTERNATE SOURCE Intake:
5-6: 0.50 μg Pb/day

CALCULATED BLOOD Pb and Pb UPTAKES:

Year	Blood Level (μg/dL)	Total Uptake (μg/day)	Soil + Dust (μg/day)
5-6	3.8	12.38	5.09

Year	Diet Uptake (μg/day)	Water Uptake (μg/day)	Alternate Source Uptake (μg/day)	Air Uptake (μg/day)
5-6	2.99	4.10	0.12	0.09

Table 6.2.1.46
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 020
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	9.4E-06	ND	1.0E-06
SUM Hazard Index/ILCR			ND	ND	9E-06	ND	1E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.1.47
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 020
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	4.2E-06	ND	1.7E-06
SUM Hazard Index/ILCR				ND	ND	4E-06	ND	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.1.48
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 121
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.0004	NA	0.030	0.283	ND	0.0108	ND
Aroclor-1248	NA	7.7	ND	ND	9.7E-07	ND	1.1E-07
Aroclor-1254	2E-05	7.7	0.14	1.3	2.5E-05	0.051	2.8E-06
Aroclor-1260	NA	7.7	ND	ND	8.6E-06	ND	9.6E-07
Arsenic	0.0003	1.5	0.059	0.55	3.0E-05	0.021	3.4E-06
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	1.5E-05	ND	1.7E-06
Beryllium	0.005	4.3	0.0020	0.018	4.9E-05	0.00071	5.4E-06
Chromium	1	NA	0.00012	0.0012	ND	0.000044	ND
Copper	0.0371	NA	0.15	1.4	ND	0.054	ND
Lead	NA	NA	ND	ND	ND	ND	ND
Manganese	0.14	NA	0.005	0.05	ND	0.002	ND
Mercury	0.0003	NA	0.01598	0.149	ND	0.0057	ND
Nickel	0.02	NA	0.062	0.58	ND	0.022	ND
Thallium	8E-05	NA	0.014	0.13	ND	0.005	ND
Vanadium	0.007	NA	0.051	0.48	ND	0.0183	ND
Zinc	0.3	NA	0.051	0.47	ND	0.0181	ND
SUM Hazard Index/ILCR			0.6	5	1E-04	0.2	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.1.49
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 121
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.2	8E-05	NA	0.0062	0.0205	ND	0.0044	ND
Aroclor-1248	0.5	NA	15.4	ND	ND	4.4E-07	ND	1.8E-07
Aroclor-1254	0.5	1E-05	15.4	0.12	0.39	1.1E-05	0.084	4.6E-06
Aroclor-1260	0.5	NA	15.4	ND	ND	3.9E-06	ND	1.6E-06
Arsenic	0.2	6E-05	7.5	0.012	0.040	3.4E-06	0.0086	1.4E-06
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	6.8E-06	ND	2.8E-06
Beryllium	0.2	0.001	21.5	0.00040	0.00134	5.4E-06	0.00029	2.2E-06
Chromium	0.2	0.2	NA	0.000025	0.000084	ND	0.000018	ND
Copper	0.2	0.00742	NA	0.031	0.101	ND	0.022	ND
Lead	0.2	NA	NA	ND	ND	ND	ND	ND
Manganese	0.2	0.028	NA	0.001	0.004	ND	0.0008	ND
Mercury	0.2	6E-05	NA	0.0033	0.0108	ND	0.00234	ND
Nickel	0.2	0.004	NA	0.013	0.042	ND	0.0091	ND
Thallium	0.2	1.6E-05	NA	0.003	0.010	ND	0.0021	ND
Vanadium	0.2	0.0014	NA	0.0106	0.0347	ND	0.0075	ND
Zinc	0.2	0.06	NA	0.0104	0.0343	ND	0.0074	ND
SUM Hazard Index/ILCR				0.2	0.7	3E-05	0.1	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.1.50
NAVBASE — Charleston Zone H
SWMU 121
USEPA LEAD MODEL Version 0.99d Output

AIR CONCENTRATION: 0.100 μg Pb/m³ DEFAULT

Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m³/day)	Lung Abs. (%)
5-6	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 15.00 μg Pb/L
(set equal to the USEPA Office of Water Treatment Technique AL)
WATER Consumption: Default

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (μg Pb/g)	House Dust (μg Pb/g)
5-6	200.0	200.0

Additional Dust Sources: None DEFAULT

ALTERNATE SOURCE Intake:
5-6: 0.50 μg Pb/day

CALCULATED BLOOD Pb and Pb UPTAKES:

Year	Blood Level (μg/dL)	Total Uptake (μg/day)	Soil + Dust (μg/day)
5-6	3.8	12.31	5.09

Year	Diet Uptake (μg/day)	Water Uptake (μg/day)	Alternate Source Uptake (μg/day)	Air Uptake (μg/day)
5-6	2.99	4.10	0.04	0.09

Table 6.2.1.51
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 649
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.3E-06	ND	2.6E-07
Mercury	0.0003	NA	0.032	0.29	ND	0.011	ND
SUM Hazard Index/ILCR			0.03	0.3	2E-06	0.01	3E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.1.52
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 649
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.0E-06	ND	4.2E-07
Mercury	0.2	6E-05	NA	0.0065	0.021	ND	0.0046	ND
SUM Hazard Index/ILCR				0.006	0.02	1E-06	0.005	4E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.1.53
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 650
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	2E-05	7.7	0.028	0.26	4.9E-06	0.010	5.5E-07
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	3.5E-05	ND	3.9E-06
Copper	0.0371	NA	0.013	0.12	ND	0.0047	ND
SUM Hazard Index/ILCR			0.04	0.4	4E-05	0.01	4E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.1.54
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 650
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	0.5	1E-05	15.4	0.023	0.075	2.2E-06	0.016	9.0E-07
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.6E-05	ND	6.4E-06
Copper	0.2	0.00742	NA	0.0027	0.0089	ND	0.0019	ND
SUM Hazard Index/ILCR				0.03	0.08	2E-05	0.02	7E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.1.55
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion - First Quarter
SWMU 9
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Azobenzene	ND	0.11	NA	NA	2.4E-06	NA	7.7E-07
Chlorobenzene	0.02	ND	0.1605	0.375	NA	0.0573	NA
Chromium (trivalent)	1	ND	0.0007	0.0015	NA	0.00024	NA
1,4-Dichlorobenzene	0.229	0.024	0.0003	0.001	9.9E-07	0.0001	3.2E-07
1,2-Dichloroethane	ND	0.091	NA	NA	9.3E-06	NA	3.0E-06
1,2-Dichloroethene (total)	0.009	ND	0.0237	0.055	NA	0.0085	NA
Antimony	0.0004	ND	0.61110	1.42589	NA	0.21825	NA
Barium	0.07	ND	0.32708	0.76318	NA	0.11681	NA
Benzene	ND	0.029	NA	NA	5.4E-06	NA	1.7E-06
Benzidine	0.003	230	0.27241	0.63563	9.8E-02	0.09729	3.2E-02
Carbon disulfide	0.1	ND	0.00325	0.00759	NA	0.00116	NA
BEHP	0.02	0.014	0.00225	0.00526	3.5E-07	0.00080	1.1E-07
Copper	0.0371	ND	0.01263	0.02947	NA	0.00451	NA
2,4-Dimethylphenol	0.02	ND	0.06909	0.16120	NA	0.02467	NA
2,3,7,8-TCDD equivalents	ND	150000	NA	NA	6.3E-06	NA	2.0E-06
Ethylbenzene	0.1	ND	0.00676	0.01578	NA	0.00242	NA
bis(2-Chloroethyl)ether	ND	1.1	NA	NA	1.9E-04	NA	6.1E-05
Hexachlorocyclopentadiene	0.007	ND	0.02333	0.05445	NA	0.00833	NA
Lead	ND	ND	NA	NA	NA	NA	NA
2-Methylphenol	0.05	ND	0.00500	0.01166	NA	0.00178	NA
4-Methylphenol	0.005	ND	0.37195	0.86787	NA	0.13284	NA
Pentachlorophenol	0.03	0.12	0.00173	0.00403	3.4E-06	0.00062	1.1E-06
Vanadium	0.007	ND	0.04263	0.09946	NA	0.01522	NA
Vinyl chloride	ND	1.9	NA	NA	8.1E-04	NA	2.6E-04
SUM Hazard Index/ILCR			2	5	1E-01	0.7	3E-02

NOTES:

-	ILCR for benzidine was estimated using the one-hit calculation from RAGS
NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk

Table 6.2.1.56
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater - First Quarter
SWMU 9
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Azobenzene	ND	0.108	NA	NA	1.9E-04	NA	6.1E-05
Chlorobenzene	0.00571	ND	0.562	1.3	NA	0.20	NA
Chromium (trivalent)	1	ND	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	0.229	0.024	0.0003	0.0008	9.9E-07	0.00012	3.2E-07
1,2-Dichloroethane	0.00286	0.091	0.065	0.15	9.3E-06	0.023	3.0E-06
1,2-Dichloroethene (total)	0.04	ND	0.005	0.012	NA	0.0019	NA
Antimony	0.0004	ND	NA	NA	NA	NA	NA
Barium	0.07	ND	NA	NA	NA	NA	NA
Benzene	0.00171	0.029	0.20	0.46	5.4E-06	0.071	1.7E-06
Benzidine	0.003	235	NA	NA	NA	NA	NA
Carbon disulfide	0.00286	ND	0.11	0.27	NA	0.041	NA
BEHP	0.02	0.014	NA	NA	NA	NA	NA
Copper	0.0371	ND	NA	NA	NA	NA	NA
2,4-Dimethylphenol	0.02	ND	NA	NA	NA	NA	NA
2,3,7,8-TCDD equivalents	ND	150000	NA	NA	NA	NA	NA
Ethylbenzene	0.286	ND	0.0024	0.006	NA	0.0008	NA
bis(2-Chloroethyl)ether	ND	1.16	NA	NA	2.0E-04	NA	6.4E-05
Hexachlorocyclopentadiene	2E-05	ND	8.2	19	NA	2.9	NA
Lead	ND	ND	NA	NA	NA	NA	NA
2-Methylphenol	0.05	ND	NA	NA	NA	NA	NA
4-Methylphenol	0.005	ND	NA	NA	NA	NA	NA
Pentachlorophenol	0.03	0.12	NA	NA	NA	NA	NA
Vanadium	0.007	ND	NA	NA	NA	NA	NA
Vinyl chloride	ND	0.3	NA	NA	1.3E-04	NA	4.1E-05
SUM Hazard Index/ILCR			9	21	5E-04	3	2E-04

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)
- ILCR for benzidine was estimated using the one-hit calculation from RAGS

Table 6.2.1.57
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion - Second Quarter
SWMU 9
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Chlorobenzene	0.02	ND	0.1569	0.366	NA	0.0561	NA
1,4-Dichlorobenzene	0.229	0.024	0.0005	0.001	1.4E-06	0.0002	4.4E-07
1,2-Dichloroethane	ND	0.091	NA	NA	9.8E-06	NA	3.1E-06
1,2-Dichloroethene (total)	0.009	ND	0.0358	0.083	NA	0.0128	NA
Methylene chloride	0.06	0.0075	0.0069	0.016	1.7E-06	0.0025	5.5E-07
Trichloroethene	0.006	0.011	0.02	0.04	5.7E-07	0.0056	1.8E-07
Beryllium	0.005	4.3	0.00204	0.00476	2.4E-05	0.00073	7.7E-06
Arsenic	0.0003	1.5	3.07991	7.18645	7.6E-04	1.09997	2.4E-04
Barium	0.07	ND	0.40515	0.94534	NA	0.14470	NA
Benzene	ND	0.029	NA	NA	4.8E-06	NA	1.5E-06
Cadmium	0.0005	ND	0.05616	0.13105	NA	0.02006	NA
Copper	0.0371	ND	0.01066	0.02488	NA	0.00381	NA
2,4-Dimethylphenol	0.02	ND	0.05352	0.12487	NA	0.01911	NA
Hexachlorobenzene	0.0008	1.6	0.41264	0.96282	2.9E-04	0.14737	9.3E-05
Hexachlorobutadiene	0.0002	0.078	0.21918	0.51142	1.9E-06	0.07828	6.0E-07
Hexachloroethane	0.001	0.014	0.04211	0.09826	3.2E-07	0.01504	1.0E-07
Lead	ND	ND	NA	NA	NA	NA	NA
4-Methylphenol	0.005	ND	0.21962	0.51244	NA	0.07843	NA
Vanadium	0.007	ND	0.03537	0.08253	NA	0.01263	NA
Vinyl chloride	ND	1.9	NA	NA	7.8E-04	NA	2.5E-04
SUM Hazard Index/ILCR			5	11	2E-03	2	6E-04

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.1.58
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater - Second Quarter
SWMU 9
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Chlorobenzene	0.00571	ND	0.550	1.283	NA	0.1963	NA
1,4-Dichlorobenzene	0.229	0.024	0.0005	0.001	1.4E-06	0.0002	4.4E-07
1,2-Dichloroethane	0.00286	0.091	0.069	0.160	9.8E-06	0.0245	3.1E-06
1,2-Dichloroethene (total)	0.04	ND	0.008	0.019	NA	0.003	NA
Methylene chloride	0.857	0.00164	0.00049	0.0011	3.8E-07	0.00017	1.2E-07
Trichloroethene	0.0571	0.006	0.002	0.004	3.1E-07	0.00059	1.0E-07
Beryllium	0.0571	0.006	NA	NA	NA	NA	NA
Arsenic	0.0003	1.5	NA	NA	NA	NA	NA
Barium	0.07	ND	NA	NA	NA	NA	NA
Benzene	0.00171	0.029	0.175	0.407	4.8E-06	0.06235	1.5E-06
Cadmium	0.0005	ND	NA	NA	NA	NA	NA
Copper	0.0371	ND	NA	NA	NA	NA	NA
2,4-Dimethylphenol	0.02	ND	NA	NA	NA	NA	NA
Hexachlorobenzene	0.0008	1.61	0.413	0.963	2.9E-04	0.14737	9.3E-05
Hexachlorobutadiene	0.0002	0.077	0.219	0.511	1.9E-06	0.07828	5.9E-07
Hexachloroethane	0.001	0.014	0.042	0.098	3.2E-07	0.01504	1.0E-07
Lead	ND	ND	NA	NA	NA	NA	NA
4-Methylphenol	0.005	ND	NA	NA	NA	NA	NA
Vanadium	0.007	ND	NA	NA	NA	NA	NA
Vinyl chloride	ND	0.3	NA	NA	1.2E-04	NA	3.9E-05
SUM Hazard Index/ILCR			1	3	4E-04	0.5	1E-04

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.1.59
Hazard Quotients and Incremental Lifetime Cancer Risks
Deep Groundwater Ingestion
SWMU 9 - First Quarter
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Chromium (trivalent)	1	ND	0.0005	0.0012	NA	0.00018	NA
Cadmium	0.0005	ND	0.12055	0.28128	NA	0.04305	NA
Carbon disulfide	0.1	ND	0.01671	0.03900	NA	0.00597	NA
Chloroform	0.01	0.0061	0.00658	0.01534	2.2E-07	0.00235	7.0E-08
Manganese	0.005	ND	4.41096	10.29224	NA	1.57534	NA
Thallium	8E-05	ND	54.79452	127.85388	NA	19.56947	NA
SUM Hazard Index/ILCR			59	138	2E-07	21	7E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.1.60
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Deep Groundwater
SWMU 9 - First Quarter
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Chromium (trivalent)	1	ND	NA	NA	NA	NA	NA
Cadmium	0.0005	ND	NA	NA	NA	NA	NA
Carbon disulfide	0.00286	ND	0.584	1.363	NA	0.20870	NA
Chloroform	0.01	0.0805	0.007	0.015	2.9E-06	0.00235	9.3E-07
Manganese	0.005	ND	NA	NA	NA	NA	NA
Thallium	8E-05	ND	NA	NA	NA	NA	NA
SUM Hazard Index/ILCR			0.6	1	3E-06	0.2	9E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.1.61
Hazard Quotients and Incremental Lifetime Cancer Risks
Deep Groundwater Ingestion
SWMU 9 - Second Quarter
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Cadmium	0.0005	ND	0.17534	0.40913	NA	0.06262	NA
Manganese	0.005	ND	6.95890	16.23744	NA	2.48532	NA
SUM Hazard Index/ILCR			7	17	NA	3	NA

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW02D	GD	Manganese	01	73.3000		UG/L	0.94	
009GW02D	GD	Manganese	02	184.0000		UG/L	2.35	
009GW03D	GD	Arsenic	01	4.0000	J	UG/L	0.85	9.0E-05
009GW03D	GD	Lead	01	6.9000	J	UG/L		
009GW03D	GD	Manganese	01	805.0000		UG/L	10.29	
009GW03D	GD	Barium	01	176.0000		UG/L	0.16	
009GW03D	GD	Vanadium	01	5.8000	J	UG/L	0.05	
009GW03D	GD	Manganese	02	1220.0000		UG/L	15.60	
009GW03D	GD	Cadmium	02	2.6000	J	UG/L	0.33	
009GW04D	GD	Arsenic	01	4.6000	J	UG/L	0.98	1.0E-04
009GW04D	GD	Lead	01	4.0000	J	UG/L		
009GW04D	GD	Manganese	01	26.6000		UG/L	0.34	
009GW04D	GD	Thallium	01	160.0000	J	UG/L	127.85	
009GW04D	GD	Barium	01	74.1000	J	UG/L	0.07	
009GW04D	GD	Vanadium	01	12.2000		UG/L	0.11	
009GW04D	GD	Carbon disulfide	01	61.0000		UG/L	1.40	
009GW04D	GD	Manganese	02	16.6000	B	UG/L	0.21	
009GW04D	GD	Cadmium	02	2.7000	J	UG/L	0.35	
009GW05D	GD	Manganese	01	94.0000		UG/L	1.20	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW05D	GD	Manganese	02	252.0000		UG/L	3.22	
009GW06D	GD	Chloroform	01	2.4000	J	UG/L	0.03	3.1E-06
009GW06D	GD	Manganese	01	139.0000	J	UG/L	1.78	
009GW06D	GD	Barium	01	75.5000	J	UG/L	0.07	
009GW06D	GD	Arsenic	02	4.1000	J	UG/L	0.87	9.3E-05
009GW06D	GD	Manganese	02	278.0000		UG/L	3.55	
009GW06D	GD	Cadmium	02	3.2000	J	UG/L	0.41	
009GW07D	GD	Arsenic	01	4.8000	J	UG/L	1.02	1.1E-04
009GW07D	GD	Lead	01	4.6000	J	UG/L		
009GW07D	GD	Manganese	01	755.0000		UG/L	9.65	
009GW07D	GD	Barium	01	68.6000	J	UG/L	0.06	
009GW07D	GD	Vanadium	01	4.5000	J	UG/L	0.04	
009GW07D	GD	Manganese	02	1270.0000		UG/L	16.24	
009GW08D	GD	Manganese	01	211.0000	J	UG/L	2.70	
009GW08D	GD	Manganese	02	321.0000		UG/L	4.10	
009GW12D	GD	Arsenic	01	2.3000	J	UG/L	0.49	5.2E-05
009GW12D	GD	Lead	01	2.2000	J	UG/L		
009GW12D	GD	Manganese	01	719.0000		UG/L	9.19	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW12D	GD	Barium	01	59.6000	J	UG/L	0.05	
009GW12D	GD	Cadmium	01	2.2000	J	UG/L	0.28	
009GW12D	GD	Vanadium	01	8.2000	J	UG/L	0.07	
009GW12D	GD	Manganese	02	990.0000		UG/L	12.66	
009GFMW4	GS	Benzidine	01	54.0000	J	UG/L	2.30	2.7E-01
009GFMW4	GS	Benzene	01	4.6000	J	UG/L	0.17	4.0E-06
009GFMW4	GS	1,4-Dichlorobenzene	01	3.1000	J	UG/L	0.002	2.2E-06
009GFMW4	GS	Chlorobenzene	01	20.0000		UG/L	0.29	
009GFMW4	GS	Manganese	01	272.0000		UG/L	3.48	
009GFMW4	GS	Thallium	01	4.6000	J	UG/L	3.68	
009GFMW4	GS	Copper	01	190.0000		UG/L	0.33	
009GFMW4	GS	Vanadium	01	6.7000	J	UG/L	0.06	
009GFMW4	GS	Benzene	02	4.2000	J	UG/L	0.16	3.7E-06
009GFMW4	GS	Chlorobenzene	02	9.0000		UG/L	0.13	
009GFMW4	GS	Manganese	02	380.0000		UG/L	4.86	
009GFMW4	GS	Barium	02	312.0000		UG/L	0.28	
009GW001	GS	Ethylbenzene	01	150.0000	J	UG/L	0.19	
009GW001	GS	Arsenic	01	1.8000	J	UG/L	0.38	4.1E-05
009GW001	GS	Benzene	01	1.8000	J	UG/L	0.07	1.6E-06
009GW001	GS	2,4-Dimethylphenol	01	56.0000		UG/L	0.18	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW001	GS	4-Methylphenol	01	2.1000	J	UG/L	0.03	
009GW001	GS	Lead	01	17.4000		UG/L		
009GW001	GS	Manganese	01	15.3000		UG/L	0.20	
009GW001	GS	Barium	01	206.0000		UG/L	0.19	
009GW001	GS	2-Methylphenol	01	3.9000	J	UG/L	0.005	
009GW001	GS	Ethylbenzene	02	71.0000	J	UG/L	0.09	
009GW001	GS	2,4-Dimethylphenol	02	51.5000		UG/L	0.16	
009GW001	GS	Lead	02	4.5000		UG/L		
009GW001	GS	Manganese	02	13.6000	J	UG/L	0.17	
009GW001	GS	Barium	02	178.5000	J	UG/L	0.16	
009GW001	GS	Copper	02	7.2000	J	UG/L	0.01	
009GW001	GS	2-Methylphenol	02	3.3000	J	UG/L	0.004	
009GW002	GS	2,3,7,8-TCDD equivalents	01	2.7980		PG/L		6.3E-06
009GW002	GS	Arsenic	01	1.4000	J	UG/L	0.30	3.2E-05
009GW002	GS	Manganese	01	1220.0000		UG/L	15.60	
009GW002	GS	Manganese	02	1990.0000		UG/L	25.44	
009GW003	GS	Arsenic	01	10.5000		UG/L	2.24	2.4E-04
009GW003	GS	Ethylbenzene	01	3.2000	J	UG/L	0.004	
009GW003	GS	Benzene	01	1.9000	J	UG/L	0.07	1.7E-06
009GW003	GS	2,4-Dimethylphenol	01	18.0000		UG/L	0.06	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW003	GS	Lead	01	13.6000		UG/L		
009GW003	GS	Manganese	01	35.1000		UG/L	0.45	
009GW003	GS	Thallium	01	1.0000	J	UG/L	0.80	
009GW003	GS	Barium	01	884.0000		UG/L	0.81	
009GW003	GS	Vanadium	01	9.1000	J	UG/L	0.08	
009GW003	GS	2-Methylphenol	01	4.6000	J	UG/L	0.01	
009GW003	GS	Arsenic	02	8.4000	J	UG/L	1.79	1.9E-04
009GW003	GS	2,4-Dimethylphenol	02	16.0000		UG/L	0.05	
009GW003	GS	Manganese	02	43.5000	B	UG/L	0.56	
009GW003	GS	Barium	02	1410.0000		UG/L	1.29	
009GW003	GS	2-Methylphenol	02	3.7000	J	UG/L	0.005	
009GW004	GS	2,3,7,8-TCDD equivalents	01	1.5857		PG/L		3.6E-06
009GW004	GS	Arsenic	01	2.2000	J	UG/L	0.47	5.0E-05
009GW004	GS	Lead	01	9.0000	J	UG/L		
009GW004	GS	Manganese	01	184.0000		UG/L	2.35	
009GW004	GS	Barium	01	107.0000		UG/L	0.10	
009GW004	GS	Carbon disulfide	01	80.5000		UG/L	1.85	
009GW004	GS	Manganese	02	328.0000		UG/L	4.19	
009GW005	GS	2,3,7,8-TCDD equivalents	01	2.6182		PG/L		5.9E-06
009GW005	GS	Arsenic	01	4.8000	J	UG/L	1.02	1.1E-04

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW005	GS	Manganese	01	104.0000		UG/L	1.33	
009GW005	GS	Barium	01	43.6000	J	UG/L	0.04	
009GW005	GS	Carbon disulfide	01	21.1000		UG/L	0.49	
009GW005	GS	Arsenic	02	4.1000	J	UG/L	0.87	9.3E-05
009GW005	GS	Manganese	02	130.0000		UG/L	1.66	
009GW006	GS	Manganese	01	56.7000	J	UG/L	0.72	
009GW006	GS	Barium	01	60.9000	J	UG/L	0.06	
009GW006	GS	Vanadium	01	101.0000		UG/L	0.92	
009GW006	GS	Hexachlorobenzene	02	74.0000		UG/L	11.83	3.6E-03
009GW006	GS	Arsenic	02	3.8000	J	UG/L	0.81	8.6E-05
009GW006	GS	Hexachlorobutadiene	02	2.8000	J	UG/L	1.79	6.5E-06
009GW006	GS	Hexachloroethane	02	2.7000	J	UG/L	0.35	1.1E-06
009GW006	GS	Chlorobenzene	02	2.1000	J	UG/L	0.03	
009GW006	GS	Manganese	02	178.0000		UG/L	2.28	
009GW006	GS	Copper	02	154.0000		UG/L	0.27	
009GW006	GS	Vanadium	02	67.9000		UG/L	0.62	
009GW007	GS	Vinyl chloride	01	720.0000		UG/L		2.4E-02
009GW007	GS	bis(2-Chloroethyl)ether	01	140.0000	J	UG/L		4.8E-03
009GW007	GS	Ethylbenzene	01	99.0000	J	UG/L	0.13	
009GW007	GS	1,2-Dichloroethane	01	59.0000		UG/L	1.32	1.6E-04

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW007	GS	Arsenic	01	2.4000	J	UG/L	0.51	5.4E-05
009GW007	GS	Benzene	01	11.0000	J	UG/L	0.41	9.6E-06
009GW007	GS	2,4-Dimethylphenol	01	1700.0000	J	UG/L	5.43	
009GW007	GS	4-Methylphenol	01	4400.0000	J	UG/L	56.26	
009GW007	GS	Chlorobenzene	01	63.0000	J	UG/L	0.91	
009GW007	GS	1,2-Dichloroethene (total)	01	86.0000		UG/L	0.75	
009GW007	GS	Lead	01	2.4000	J	UG/L		
009GW007	GS	Manganese	01	413.0000		UG/L	5.28	
009GW007	GS	Barium	01	419.0000		UG/L	0.38	
009GW007	GS	Vanadium	01	7.2000	J	UG/L	0.07	
009GW007	GS	2-Methylphenol	01	270.0000	J	UG/L	0.35	
009GW007	GS	Vinyl chloride	02	415.0000		UG/L		1.4E-02
009GW007	GS	Ethylbenzene	02	77.5000		UG/L	0.10	
009GW007	GS	1,2-Dichloroethane	02	58.0000		UG/L	1.30	1.6E-04
009GW007	GS	Beryllium	02	1.4000	J	UG/L	0.02	9.1E-05
009GW007	GS	Methylene chloride	02	130.0000	J	UG/L	0.15	1.8E-05
009GW007	GS	Benzene	02	10.5000	J	UG/L	0.39	9.2E-06
009GW007	GS	Trichloroethene	02	9.0000	J	UG/L	0.11	2.3E-06
009GW007	GS	2,4-Dimethylphenol	02	405.0000		UG/L	1.29	
009GW007	GS	4-Methylphenol	02	820.0000		UG/L	10.48	
009GW007	GS	Chlorobenzene	02	39.0000		UG/L	0.56	
009GW007	GS	1,2-Dichloroethene (total)	02	160.0000		UG/L	1.39	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW007	GS	Manganese	02	492.6667	J	UG/L	6.30	
009GW007	GS	Barium	02	407.0000	J	UG/L	0.37	
009GW007	GS	2-Methylphenol	02	42.0000	J	UG/L	0.05	
009GW008	GS	Manganese	01	1190.0000	J	UG/L	15.21	
009GW008	GS	Barium	01	248.0000		UG/L	0.23	
009GW008	GS	Arsenic	02	75.0000		UG/L	15.98	1.7E-03
009GW008	GS	Manganese	02	366.0000		UG/L	4.68	
009GW008	GS	Barium	02	480.0000		UG/L	0.44	
009GW009	GS	Arsenic	01	11.5000		UG/L	2.45	2.6E-04
009GW009	GS	Benzene	01	2.9000	J	UG/L	0.11	2.5E-06
009GW009	GS	Lead	01	52.6000		UG/L		
009GW009	GS	Manganese	01	385.0000		UG/L	4.92	
009GW009	GS	Thallium	01	1.4000	J	UG/L	1.12	
009GW009	GS	Barium	01	84.0000	J	UG/L	0.08	
009GW009	GS	Vanadium	01	3.7000	J	UG/L	0.03	
009GW009	GS	Arsenic	02	5.7000	J	UG/L	1.21	1.3E-04
009GW009	GS	Benzene	02	7.0000		UG/L	0.26	6.1E-06
009GW009	GS	Lead	02	33.5000		UG/L		
009GW009	GS	Manganese	02	385.0000		UG/L	4.92	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW010	GS	Ethylbenzene	01	55.0000		UG/L	0.07	
009GW010	GS	Benzene	01	180.0000		UG/L	6.73	1.6E-04
009GW010	GS	1,4-Dichlorobenzene	01	7.5000	J	UG/L	0.00	5.4E-06
009GW010	GS	BEHP	01	2.4000	J	UG/L	0.01	5.1E-07
009GW010	GS	Chlorobenzene	01	1300.0000		UG/L	18.71	
009GW010	GS	Manganese	01	226.0000		UG/L	2.89	
009GW010	GS	Vanadium	01	8.4000	J	UG/L	0.08	
009GW010	GS	Ethylbenzene	02	20.5000		UG/L	0.03	
009GW010	GS	Benzene	02	85.0000		UG/L	3.18	7.4E-05
009GW010	GS	1,4-Dichlorobenzene	02	9.0500	J	UG/L	0.01	6.5E-06
009GW010	GS	Chlorobenzene	02	520.0000	J	UG/L	7.48	
009GW010	GS	Lead	02	1.9000	J	UG/L		
009GW010	GS	Manganese	02	323.6667		UG/L	4.14	
009GW010	GS	Barium	02	370.0000	J	UG/L	0.34	
009GW011	GS	Manganese	01	471.0000		UG/L	6.02	
009GW011	GS	Vanadium	01	3.3000	J	UG/L	0.03	
009GW011	GS	Arsenic	02	35.9000		UG/L	7.65	8.1E-04
009GW011	GS	Manganese	02	701.0000		UG/L	8.96	
009GW012	GS	Benzene	01	2.6000	J	UG/L	0.10	2.3E-06
009GW012	GS	Chlorobenzene	01	14.0000		UG/L	0.20	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW012	GS	Manganese	01	1700.0000		UG/L	21.74	
009GW012	GS	Barium	01	92.3000	J	UG/L	0.08	
009GW012	GS	Arsenic	02	22.6000		UG/L	4.82	5.1E-04
009GW012	GS	Lead	02	5.4000		UG/L		
009GW012	GS	Manganese	02	1850.0000		UG/L	23.65	
009GW012	GS	Cadmium	02	1.6000	J	UG/L	0.20	
009GW013	GS	Arsenic	01	1.3000	J	UG/L	0.28	2.9E-05
009GW013	GS	1,4-Dichlorobenzene	01	7.3000	J	UG/L	0.004	5.3E-06
009GW013	GS	Benzene	01	4.4000	J	UG/L	0.16	3.8E-06
009GW013	GS	Chlorobenzene	01	31.0000	J	UG/L	0.45	
009GW013	GS	Lead	01	2.8000	J	UG/L		
009GW013	GS	Manganese	01	518.0000		UG/L	6.62	
009GW013	GS	Thallium	01	1.0000	J	UG/L	0.80	
009GW013	GS	Barium	01	155.0000		UG/L	0.14	
009GW013	GS	Vanadium	01	6.3000	J	UG/L	0.06	
009GW013	GS	1,4-Dichlorobenzene	02	5.6000	J	UG/L	0.003	4.1E-06
009GW013	GS	Benzene	02	2.6000	J	UG/L	0.10	2.3E-06
009GW013	GS	Chlorobenzene	02	18.0000		UG/L	0.26	
009GW013	GS	Lead	02	1.9000	J	UG/L		
009GW013	GS	Manganese	02	813.0000		UG/L	10.39	
009GW013	GS	Barium	02	216.0000		UG/L	0.20	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW013	GS	Cadmium	02	1.7000	J	UG/L	0.22	
009GW014	GS	Benzene	01	9.0000		UG/L	0.34	7.9E-06
009GW014	GS	1,4-Dichlorobenzene	01	3.3000	J	UG/L	0.00	2.4E-06
009GW014	GS	Chlorobenzene	01	61.0000		UG/L	0.88	
009GW014	GS	Manganese	01	980.0000		UG/L	12.53	
009GW014	GS	Barium	01	283.0000		UG/L	0.26	
009GW014	GS	Arsenic	02	25.4000		UG/L	5.41	5.7E-04
009GW014	GS	Benzene	02	4.3000	J	UG/L	0.16	3.8E-06
009GW014	GS	Chlorobenzene	02	25.0000		UG/L	0.36	
009GW014	GS	Lead	02	1.9000	J	UG/L		
009GW014	GS	Manganese	02	1220.0000		UG/L	15.60	
009GW014	GS	Barium	02	281.0000		UG/L	0.26	
009GW014	GS	Cadmium	02	1.8000	J	UG/L	0.23	
009GW015	GS	Manganese	01	1230.0000		UG/L	15.73	
009GW015	GS	Barium	01	409.0000		UG/L	0.37	
009GW015	GS	Arsenic	02	7.3000	J	UG/L	1.56	1.7E-04
009GW015	GS	Lead	02	4.2000	J	UG/L		
009GW015	GS	Manganese	02	541.0000		UG/L	6.92	
009GW015	GS	Barium	02	534.0000		UG/L	0.49	
009GW015	GS	Cadmium	02	1.3000	J	UG/L	0.17	

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW016	GS	2,3,7,8-TCDD equivalents	01	1.6095		PG/L		3.6E-06
009GW016	GS	Pentachlorophenol	01	24.0000	J	UG/L	0.05	4.3E-05
009GW016	GS	Azobenzene	01	2.6000	J	UG/L		8.5E-06
009GW016	GS	Benzene	01	2.8000	J	UG/L	0.10	2.4E-06
009GW016	GS	BEHP	01	5.2000	J	UG/L	0.02	1.1E-06
009GW016	GS	2,4-Dimethylphenol	01	6.6333	J	UG/L	0.02	
009GW016	GS	4-Methylphenol	01	27.2000		UG/L	0.35	
009GW016	GS	Chlorobenzene	01	9.0000		UG/L	0.13	
009GW016	GS	Lead	01	20.6000		UG/L		
009GW016	GS	Manganese	01	493.0000		UG/L	6.30	
009GW016	GS	Antimony	01	18.8000	J	UG/L	3.00	
009GW016	GS	Barium	01	760.0000		UG/L	0.69	
009GW016	GS	Cadmium	01	1.2000	J	UG/L	0.15	
009GW016	GS	Hexachlorocyclopentadiene	01	11.0000	J	UG/L	35.26	
009GW017	GS	Pentachlorophenol	01	11.0000	J	UG/L	0.02	2.0E-05
009GW017	GS	Manganese	01	127.0000		UG/L	1.62	
009GW017	GS	Barium	01	499.0000		UG/L	0.46	
009GW018	GS	Pentachlorophenol	01	11.0000	J	UG/L	0.02	2.0E-05
009GW018	GS	Lead	01	8.2000		UG/L		

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
009GW018	GS	Manganese	01	320.0000		UG/L	4.09	
009GW018	GS	Barium	01	1200.0000		UG/L	1.10	
009GW019	GS	Chlorobenzene	01	28.0000		UG/L	0.40	
009GW019	GS	Lead	01	2.8000	J	UG/L		
009GW019	GS	Manganese	01	531.0000		UG/L	6.79	
009GW019	GS	Barium	01	401.0000		UG/L	0.37	
009GW121	GS	Benzene	01	3.2000	J	UG/L	0.12	2.8E-06
009GW121	GS	4-Methylphenol	01	3.2000	J	UG/L	0.04	
009GW121	GS	Chlorobenzene	01	9.0000		UG/L	0.13	
009GW121	GS	Manganese	01	196.0000		UG/L	2.51	
009GW121	GS	Thallium	01	6.4000	J	UG/L	5.11	
009GW121	GS	Copper	01	6.4000	J	UG/L	0.01	
009GW121	GS	Vanadium	01	6.5000	J	UG/L	0.06	
009GW121	GS	Lead	02	4.1000	J	UG/L		
009GW121	GS	Manganese	02	260.0000		UG/L	3.32	
009GW121	GS	Barium	02	314.0000		UG/L	0.29	

NOTES:

- data represent detected concentrations only; no assumed concentrations were included

Table 6.2.1.62
Location-Specific Analysis of COPCs Detected in SWMU 9 Groundwater
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	QUARTER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)

- the one-hit equation for high carcinogenic risk levels was used to estimate shallow groundwater ingestion ILCR for benzidine in 009GFMW4 (first quarter) and for the ingestion ILCR estimated for vinyl chloride reported in first and second quarter monitoring well data for 009GW007

SITETAG site and sample location from which the sample was collected (e. g., 009 is the site designation, GW indicates groundwater, 03 indicates well number 3, and D indicates the deep WBZ).
GS data represents shallow groundwater
GD data represents deep groundwater
QUARTER indicates first or second quarters of groundwater monitoring data
RESULT reported concentration
Q data qualifier
J reported concentration was estimated by the reporting laboratory
B COPC was reported in a corresponding blank sample and could be a laboratory artifact
UG/L micrograms per liter
PG/L picograms per liter
lwa lifetime weighted average
HQ hazard quotient - calculated assuming a child resident, which included the inhalation exposure pathway (where applicable)
ILCR incremental excess lifetime cancer risk - calculated assuming the lwa for residents, which included the inhalation exposure pathway (where applicable)

e 6.2.1.63
mary of Risk and Hazard-based COCs for Combined SWMU 9
'BASE - Charleston Zone H
leston, South Carolina

ium	Exposure Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotien	Site Worker ILCR	Identification of COCs		
ace Soil										
SWMU 19	Incidental Ingestion	Antimony	0.077	0.72	ND	0.028	ND	1		
		Aroclor-1254	0.008	0.08	1.5E-06	0.003	1.6E-07		2	
		Aroclor-1260	ND	ND	5.0E-06	ND	5.5E-07		2	
		Arsenic	0.072	0.67	3.7E-05	0.026	4.1E-06	1	2	4
		Benzo(a)pyrene Equivalents	ND	ND	4.8E-06	ND	5.4E-07		2	
		Beryllium	0.0003	0.003	7.6E-06	0.00011	8.4E-07		2	
		Copper	0.112	1.05	ND	0.040	ND	1		
		Lead	ND	ND	ND	ND	ND			
		Nickel	0.018	0.17	ND	0.006	ND	1		
		Zinc	0.013	0.12	ND	0.005	ND	1		
	Dermal Contact	Antimony	0.016	0.036	ND	0.0113	ND			
		Aroclor-1254	0.0068	0.015	5.6E-07	0.0048	2.7E-07			
		Aroclor-1260	ND	ND	1.9E-06	ND	9.1E-07		2	
		Arsenic	0.015	0.034	3.6E-06	0.011	1.7E-06		2	4
		Benzo(a)pyrene Equiv.	ND	ND	1.9E-06	ND	8.8E-07		2	
		Beryllium	0.000063	0.00014	7.3E-07	0.000045	3.5E-07			
		Copper	0.02	0.05	ND	0.016	ND			
		Lead	ND	ND	ND	ND	ND			
		Nickel	0.0037	0.0083	ND	0.0026	ND			
		Zinc	0.0026	0.0060	ND	0.0019	ND			
ce Soil Pathway Sum for SWMU 19			0.4	3	6E-05	0.2	1E-05			
SWMU 20	Incidental Ingestion	Benzo(a)pyrene Equiv.	ND	ND	9.4E-06	ND	1.0E-06		2	4
	Dermal Contact	Benzo(a)pyrene Equiv.	ND	ND	4.2E-06	ND	1.7E-06		2	4
ce Soil Pathway Sum for SWMU 20			ND	ND	1E-05	ND	3E-06			
SWMU 121	Incidental Ingestion	Antimony	0.030	0.283	ND	0.0108	ND	1		
		Aroclor-1248	ND	ND	9.7E-07	ND	1.1E-07			
		Aroclor-1254	0.14	1.3	2.5E-05	0.051	2.8E-06	1	2	4
		Aroclor-1260	ND	ND	8.6E-06	ND	9.6E-07		2	
		Arsenic	0.059	0.55	3.0E-05	0.021	3.4E-06	1	2	4
		Benzo(a)pyrene Equiv.	ND	ND	1.5E-05	ND	1.7E-06		2	4
		Beryllium	0.0020	0.018	4.9E-05	0.00071	5.4E-06		2	4
		Chromium	0.00012	0.0012	ND	0.000044	ND			
		Copper	0.15	1.4	ND	0.054	ND	1		
		Lead	ND	ND	ND	ND	ND			
		Manganese	0.005	0.05	ND	0.002	ND			
		Mercury	0.01598	0.149	ND	0.0057	ND	1		
		Nickel	0.062	0.58	ND	0.022	ND	1		
		Thallium	0.014	0.13	ND	0.005	ND	1		

6.2.1.63
nary of Risk and Hazard-based COCs for Combined SWMU 9
3ASE - Charleston Zone H
eston, South Carolina

um	Exposure Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotien	Site Worker ILCR	Identification of COCs			
		Vanadium	0.051	0.48	ND	0.0183	ND	1			
		Zinc	0.051	0.47	ND	0.0181	ND	1			
	Dermal Contact	Antimony	0.0062	0.0205	ND	0.0044	ND				
		Aroclor-1248	ND	ND	4.4E-07	ND	1.8E-07				
		Aroclor-1254	0.12	0.39	1.1E-05	0.084	4.6E-06	1	2		4
		Aroclor-1260	ND	ND	3.9E-06	ND	1.6E-06		2		4
		Arsenic	0.012	0.040	3.4E-06	0.0086	1.4E-06		2		4
		Benzo(a)pyrene Equiv.	ND	ND	6.8E-06	ND	2.8E-06		2		4
		Beryllium	0.00040	0.00134	5.4E-06	0.00029	2.2E-06		2		4
		Chromium	0.000025	0.000084	ND	0.000018	ND				
		Copper	0.031	0.101	ND	0.022	ND	1			
		Lead	ND	ND	ND	ND	ND				
		Manganese	0.001	0.004	ND	0.0008	ND				
		Mercury	0.0033	0.0108	ND	0.00234	ND				
		Nickel	0.013	0.042	ND	0.0091	ND				
		Thallium	0.003	0.010	ND	0.0021	ND				
		Vanadium	0.0105	0.0347	ND	0.0075	ND				
		Zinc	0.0104	0.0343	ND	0.0074	ND				
ce Soil Pathway Sum for SWMU 121			0.8	6	2E-04	0.4	3E-05				
AOC 649	Incidental Ingestion	Benzo(a)pyrene Equiv.	ND	ND	2.3E-06	ND	2.6E-07		2		
		Mercury	0.032	0.29	ND	0.011	ND				
	Dermal Contact	Benzo(a)pyrene Equiv.	ND	ND	1.0E-06	ND	4.2E-07		2		
		Mercury	0.0065	0.021	ND	0.0046	ND				
ce Soil Pathway Sum for AOC 649			0.04	0.3	3E-06	0.02	7E-07				
AOC 650	Incidental Ingestion	Aroclor-1254	0.028	0.26	4.9E-06	0.010	5.5E-07		2		
		Benzo(a)pyrene Equiv.	ND	ND	3.5E-05	ND	3.9E-06		2		4
		Copper	0.013	0.12	ND	0.0047	ND				
	Dermal Contact	Aroclor-1254	0.023	0.075	2.2E-06	0.016	9.0E-07		2		
		Benzo(a)pyrene Equiv.	ND	ND	1.6E-05	ND	6.4E-06		2		4
		Copper	0.0027	0.0089	ND	0.0019	ND				
ce Soil Pathway Sum for AOC 650			0.07	0.5	6E-05	0.03	1E-05				
ndwater											
ow Groundwater First Quarter	Ingestion	Azobenzene	NA	NA	2.4E-06	NA	7.7E-07				
		Chlorobenzene	0.16	0.375	NA	0.057	NA				
		Chromium (trivalent)	0.0007	0.0015	NA	0.00024	NA				
		1,4-Dichlorobenzene	0.0003	0.001	9.9E-07	0.00012	3.2E-07				
		1,2-Dichloroethane	NA	NA	9.3E-06	NA	3.0E-06				4
		1,2-Dichloroethene (total)	0.0237	0.055	NA	0.0085	NA				
		Antimony	0.61	1.43	NA	0.22	NA	1		3	

le 6.2.1.63
nmary of Risk and Hazard-based COCs for Combined SWMU 9
/BASE - Charleston Zone H
rleston, South Carolina

lium	Exposure Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotien	Site Worker ILCR	Identification of COCs
		Barium	0.33	0.76	NA	0.12	NA	3
		Benzene	NA	NA	5.4E-06	NA	1.7E-06	4
		Benzidine	0.27	0.64	9.8E-02	0.097	3.2E-02	4
		Carbon disulfide	0.003	0.0076	NA	0.0012	NA	
		BEHP	0.002	0.0053	3.5E-07	0.0008	1.1E-07	
		Copper	0.013	0.029	NA	0.005	NA	
		2,4-Dimethylphenol	0.069	0.16	NA	0.025	NA	
		2,3,7,8-TCDD equivalents	NA	NA	6.3E-06	NA	2.0E-06	4
		Ethylbenzene	0.007	0.016	NA	0.002	NA	
		bis(2-Chloroethyl)ether	NA	NA	1.9E-04	NA	6.1E-05	4
		Hexachlorocyclopentadiene	0.023	0.054	NA	0.0083	NA	
		Lead	NA	NA	NA	NA	NA	
		2-Methylphenol	0.005	0.012	NA	0.0018	NA	
		4-Methylphenol	0.37	0.87	NA	0.133	NA	3
		Pentachlorophenol	0.00173	0.00403	3.4E-06	0.00062	1.1E-06	4
		Vanadium	0.043	0.099	NA	0.015	NA	
		Vinyl chloride	NA	NA	8.1E-04	NA	2.6E-04	4
	Inhalation	Azobenzene	NA	NA	1.9E-04	NA	6.1E-05	4
		Chlorobenzene	0.562	1.3	NA	0.20	NA	1 3
		Chromium (trivalent)	NA	NA	NA	NA	NA	
		1,4-Dichlorobenzene	0.0003	0.0008	9.9E-07	0.00012	3.2E-07	
		1,2-Dichloroethane	0.065	0.15	9.3E-06	0.023	3.0E-06	4
		1,2-Dichloroethene (total)	0.005	0.012	NA	0.0019	NA	
		Antimony	NA	NA	NA	NA	NA	
		Barium	NA	NA	NA	NA	NA	
		Benzene	0.20	0.46	5.4E-06	0.071	1.7E-06	4
		Benzidine	NA	NA	NA	NA	NA	
		Carbon disulfide	0.11	0.27	NA	0.041	NA	
		BEHP	NA	NA	NA	NA	NA	
		Copper	NA	NA	NA	NA	NA	
		2,4-Dimethylphenol	NA	NA	NA	NA	NA	
		2,3,7,8-TCDD equivalents	NA	NA	NA	NA	NA	
		Ethylbenzene	0.0024	0.006	NA	0.0008	NA	
		bis(2-Chloroethyl)ether	NA	NA	2.0E-04	NA	6.4E-05	4
		Hexachlorocyclopentadiene	8.2	19	NA	2.9	NA	1 3
		Lead	NA	NA	NA	NA	NA	
		2-Methylphenol	NA	NA	NA	NA	NA	
		4-Methylphenol	NA	NA	NA	NA	NA	
		Pentachlorophenol	NA	NA	NA	NA	NA	
		Vanadium	NA	NA	NA	NA	NA	
		Vinyl chloride	NA	NA	1.3E-04	NA	4.1E-05	2 4
Quarter Shallow Groundwater Pathway Sum			11	26	1E-01	4	3E-02	

6.2.1.63
mary of Risk and Hazard-based COCs for Combined SWMU 9
BASE - Charleston Zone H
eston, South Carolina

um	Exposure Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotien	Site Worker ILCR	Identification of COCs			
ep Groundwater First Quarter	Ingestion	Chromium (trivalent)	0.0005	0.0012	NA	0.00018	NA				
		Cadmium	0.12	0.28	NA	0.04	NA	1			
		Carbon disulfide	0.017	0.039	NA	0.0060	NA				
		Chloroform	0.0066	0.015	2.2E-07	0.0023	7.0E-08				
		Manganese	4.41	10.3	NA	1.58	NA	1		3	
		Thallium	54.8	128	NA	19.6	NA	1		3	
	Inhalation	Chromium (trivalent)	NA	NA	NA	NA	NA				
		Cadmium	NA	NA	NA	NA	NA				
		Carbon disulfide	0.58	1.36	NA	0.21	NA	1		3	
		Chloroform	0.007	0.015	2.9E-06	0.0023	9.3E-07		2		
		Manganese	NA	NA	NA	NA	NA				
		Thallium	NA	NA	NA	NA	NA				
Quarter Deep Groundwater Pathway Sum			60	140	3E-06	21	1E-06	1	2	3	4
low Groundwater econd Quarter	Ingestion	Chlorobenzene	0.16	0.37	NA	0.056	NA	1			
		1,4-Dichlorobenzene	0.0005	0.001	1.4E-06	0.0002	4.4E-07		2		
		1,2-Dichloroethane	NA	NA	9.8E-06	NA	3.1E-06		2		4
		1,2-Dichloroethene (total)	0.036	0.083	NA	0.013	NA				
		Methylene chloride	0.0069	0.016	1.7E-06	0.0025	5.5E-07		2		
		Trichloroethene	0.02	0.04	5.7E-07	0.0056	1.8E-07				
		Beryllium	0.002	0.0048	2.4E-05	0.00073	7.7E-06		2		4
		Arsenic	3.08	7.19	7.6E-04	1.10	2.4E-04	1	2	3	4
		Barium	0.41	0.95	NA	0.14	NA	1		3	
		Benzene	NA	NA	4.8E-06	NA	1.5E-06		2		4
		Cadmium	0.056	0.13	NA	0.020	NA	1			
		Copper	0.011	0.025	NA	0.0038	NA				
		2,4-Dimethylphenol	0.054	0.12	NA	0.019	NA	1			
		Hexachlorobenzene	0.41	0.96	2.9E-04	0.15	9.3E-05	1	2	3	4
		Hexachlorobutadiene	0.22	0.51	1.9E-06	0.078	6.0E-07	1	2		
		Hexachloroethane	0.042	0.098	3.2E-07	0.015	1.0E-07				
		Lead	NA	NA	NA	NA	NA				
		4-Methylphenol	0.22	0.51	NA	0.078	NA	1			
		Vanadium	0.035	0.083	NA	0.013	NA				
		Vinyl chloride	NA	NA	7.8E-04	NA	2.5E-04		2		4
	Inhalation	Chlorobenzene	0.55	1.28	NA	0.20	NA	1		3	
		1,4-Dichlorobenzene	0.0005	0.001	1.4E-06	0.0002	4.4E-07		2		
		1,2-Dichloroethane	0.069	0.160	9.8E-06	0.025	3.1E-06	1	2		4
		1,2-Dichloroethene (total)	0.008	0.019	NA	0.003	NA				
		Methylene chloride	0.00049	0.0011	3.8E-07	0.00017	1.2E-07				
		Trichloroethene	0.002	0.004	3.1E-07	0.00059	1.0E-07				
		Beryllium	NA	NA	NA	NA	NA				
		Arsenic	NA	NA	NA	NA	NA				

le 6.2.1.63
nmary of Risk and Hazard-based COCs for Combined SWMU 9
/BASE - Charleston Zone H
rleston, South Carolina

lium	Exposure Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotien	Site Worker ILCR	Identification of COCs			
		Barium	NA	NA	NA	NA	NA				
		Benzene	0.17	0.41	4.8E-06	0.062	1.5E-06	1	2		4
		Cadmium	NA	NA	NA	NA	NA				
		Copper	NA	NA	NA	NA	NA				
		2,4-Dimethylphenol	NA	NA	NA	NA	NA				
		Hexachlorobenzene	0.41	0.96	2.9E-04	0.15	9.3E-05	1	2	3	4
		Hexachlorobutadiene	0.22	0.51	1.9E-06	0.078	5.9E-07	1	2		
		Hexachloroethane	0.042	0.098	3.2E-07	0.015	1.0E-07				
		Lead	NA	NA	NA	NA	NA				
		4-Methylphenol	NA	NA	NA	NA	NA				
		Vanadium	NA	NA	NA	NA	NA				
		Vinyl chloride	NA	NA	1.2E-04	NA	3.9E-05		2		4
ond Quarter Shallow Groundwater Pathway Sum			6	15	2E-03	2	7E-04				
eep Groundwater	Ingestion	Cadmium	0.18	0.41	NA	0.063	NA	1			
Second Quarter		Manganese	7.0	16.2	NA	2.5	NA	1		3	
ond Quarter Deep Groundwater Pathway Sum			7	17	NA	3	NA				

s:
ndicates not applicable
ndicates not determined due to the lack of available risk information.
R indicates incremental excess lifetime cancer risk
dicates hazard index
hemical is a COC by virtue of projected child residence non-carcinogenic hazard.
hemical is a COC by virtue of projected future resident lifetime ILCR.
hemical is a COC by virtue of projected site worker non-carcinogenic hazard.
hemical is a COC by virtue of projected site worker ILCR.
zo(a)pyrene equivalents were identified as COCs for surface soil based on
ombined ingestion and dermal contact pathway risk.

e 6.2.1.64
ımary of Risk and Hazard for Combined SWMU 9
'BASE - Charleston Zone H
rleston, South Carolina

ium	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
ace Soil Pathway Sum for SWMU 19	0.4	3	6E-05	0.2	1E-05
ace Soil Pathway Sum for SWMU 20	ND	ND	1E-05	ND	3E-06
ace Soil Pathway Sum for SWMU 121	0.8	6	2E-04	0.4	3E-05
ace Soil Pathway Sum for AOC 649	0.04	0.3	3E-06	0.02	7E-07
ace Soil Pathway Sum for AOC 650	0.07	0.5	6E-05	0.03	1E-05
: Quarter Shallow Groundwater Pathway Sum	11	26	1E-01	4	3E-02
: Quarter Deep Groundwater Pathway Sum	60	140	3E-06	21	1E-06
ond Quarter Shallow Groundwater Pathway Sum	6	15	2E-03	2	7E-04
ond Quarter Deep Groundwater Pathway Sum	7	17	NA	3	NA

es:
ndicates not determined due to lack of available risk information
R indicates incremental excess lifetime cancer risk
ıdicates hazard index

Table 6.2.1.65
Residential-Based Remedial Goal Options
Naval Base Charleston, SWMU 019 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Antimony	NA	NA	22.62	89	29.8	2.98	ND	ND	ND	ND
Aroclor-1254	7.7	NA	0.12	4	1.3	0.13	0.060	0.60	6.0	ND
Aroclor-1260	7.7	NA	0.41	ND	ND	ND	0.060	0.60	6.0	ND
Arsenic	1.5	NA	15.79	67	22.3	2.23	0.388	3.88	38.8	14.81
Benzo(a)pyrene Equivalents	7.3	1	0.42	ND	ND	ND	0.063	0.63	6.3	ND
Beryllium	4.3	NA	1.12	1117	372	37.24	0.135	1.35	13.5	1.47
Copper	NA	NA	3040	8291	2764	276	ND	ND	ND	27.6
Lead	NA	NA	6170	ND	ND	ND	ND	ND	ND	118
Nickel	NA	NA	260.48	4469	1490	149	ND	ND	ND	33.38
Zinc	NA	NA	2800	67041	22347	2235	ND	ND	ND	214.3

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.1.66
Worker-Based Remedial Goal Options
Naval Base Charleston, SWMU 019 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	Hazard-Based Remedial Goal Options 1.0 mg/kg	Hazard-Based Remedial Goal Options 0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	Risk-Based Remedial Goal Options 1E-05 mg/kg	Risk-Based Remedial Goal Options 1E-04 mg/kg	Background Concentration mg/kg
Antimony	NA	NA	22.62	1740	580	58	ND	ND	ND	ND
Aroclor-1254	7.7	NA	0.12	46	15	1.5	0.282	2.82	28.2	ND
Aroclor-1260	7.7	NA	0.41	ND	ND	ND	0.282	2.82	28.2	ND
Arsenic	1.5	NA	15.79	1305	435	43	2.706	27	271	14.81
Benzo(a)pyrene Equivalents	7.3	1	0.42	ND	ND	ND	0.297	2.97	29.7	ND
Beryllium	4.3	NA	1.12	21745	7248	725	0.944	9.44	94.4	1.47
Copper	NA	NA	3040	161346	53782	5378	ND	ND	ND	27.6
Lead	NA	NA	6170	ND	ND	ND	ND	ND	ND	118
Nickel	NA	NA	260.48	86979	28993	2899	ND	ND	ND	33.38
Zinc	NA	NA	2800	1304681	434894	43489	ND	ND	ND	214.3

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.1.67
Residential-Based Remedial Goal Options
Naval Base Charleston, SWMU 020 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	Hazard-Based Remedial Goal Options 1.0 mg/kg	Hazard-Based Remedial Goal Options 0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	Risk-Based Remedial Goal Options 1E-05 mg/kg	Risk-Based Remedial Goal Options 1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	1	0.821	ND	ND	ND	0.060	0.60	6.0	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.1.68
Worker-Based Remedial Goal Options
Naval Base Charleston, SWMU 020 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	1	0.821	ND	ND	ND	0.297	2.97	29.7	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.1.69
Residential-Based Remedial Goal Options
Naval Base Charleston, SMWU 121 Surface Soils
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Antimony	0.0004	NA	NA	8.85	88	29.2	2.92	ND	ND	ND	ND
Aroclor-1248	NA	7.7	NA	0.08	NA	NA	NA	0.057	0.57	5.7	ND
Aroclor-1254	2E-05	7.7	NA	2.10	4	1.2	0.12	0.057	0.57	5.7	ND
Aroclor-1260	NA	7.7	NA	0.71	NA	NA	NA	0.057	0.57	5.7	ND
Arsenic	0.0003	1.5	NA	12.87	66	21.9	2.19	0.383	3.83	38.3	14.81
Benzo(a)pyrene Equivalents	NA	7.3	1	1.32	NA	NA	NA	0.060	0.60	6.0	ND
Beryllium	0.005	4.3	NA	7.21	1094	364.6	36.46	0.134	1.34	13.4	1.47
Chromium	1	NA	NA	90.2	218781	72927	7293	ND	ND	ND	85.65
Copper	0.0371	NA	NA	4060	8117	2706	271	ND	ND	ND	27.6
Lead	NA	NA	NA	1270	NA	NA	NA	ND	ND	ND	118
Manganese	0.14	NA	NA	560	30629	10210	1021	ND	ND	ND	636.4
Mercury	0.0003	NA	NA	3.50	66	22	2	ND	ND	ND	0.49
Nickel	0.02	NA	NA	908	4376	1459	145.9	ND	ND	ND	33.38
Thallium	8E-05	NA	NA	0.82	18	5.8	0.58	ND	ND	ND	0.63
Vanadium	0.007	NA	NA	262	1531	510	51	ND	ND	ND	77.38
Zinc	0.3	NA	NA	11106	65634	21878	2188	ND	ND	ND	214.3

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.1.70
Site Worker-Based Remedial Goal Options
Naval Base Charleston, SWMU 121 Surface Soils
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Antimony	0.0004	NA	NA	8.85	1740	580	58	ND	ND	ND	ND
Aroclor-1248	NA	7.7	NA	0.08	ND	ND	ND	0.28	2.82	28.15	ND
Aroclor-1254	2E-05	7.7	NA	2.10	46	15	1.5	0.28	2.82	28.15	ND
Aroclor-1260	NA	7.7	NA	0.71	ND	ND	ND	0.28	2.82	28.15	ND
Arsenic	0.0003	1.5	NA	12.87	1305	435	43	2.71	27.06	270.60	14.81
Benzo(a)pyrene Equivalents	NA	7.3	1	1.32	ND	ND	ND	0.30	2.97	29.70	ND
Beryllium	0.005	4.3	NA	7.21	21745	7248	725	0.94	9.44	94.40	1.47
Chromium	1	NA	NA	90.2	4348936	1449645	144965	ND	ND	ND	85.65
Copper	0.0371	NA	NA	4060	161346	53782	5378	ND	ND	ND	27.6
Lead	NA	NA	NA	1270	ND	ND	ND	ND	ND	ND	118
Manganese	0.14	NA	NA	580	608851	202950	20295	ND	ND	ND	636.4
Mercury	0.0003	NA	NA	3.50	1305	435	43	ND	ND	ND	0.49
Nickel	0.02	NA	NA	908	86979	28993	2899	ND	ND	ND	33.38
Thallium	8E-05	NA	NA	0.82	348	116	12	ND	ND	ND	0.63
Vanadium	0.007	NA	NA	262	30443	10148	1015	ND	ND	ND	77.38
Zinc	0.3	NA	NA	11105	1304681	434894	43489	ND	ND	ND	214.3

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.1.71
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 649 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 0.1 mg/kg	1.0 mg/kg	3 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	0.202	ND	ND	ND	0.060	0.60	6.0	ND
Mercury	NA	0.0003	6.9	2.188	21.88	65.6	ND	ND	ND	0.49

NOTES:

EPC exposure point concentration

NA not applicable

ND not determined

\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.1.72
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 649 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 0.1 mg/kg	1.0 mg/kg	3 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	0.202	ND	ND	ND	0.30	2.97	29.70	ND
Mercury	NA	0.0003	6.9	43	435	1305	ND	ND	ND	0.49

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.1.73
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 650 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aroclor-1254	7.7	NA	0.41	3.64	1.21	0.12	0.057	0.57	5.7	ND
Benzo(a)pyrene Equivalents	7.3	1	3.07	ND	ND	ND	0.060	0.60	6.0	ND
Copper	NA	NA	357	8117	2706	271	ND	ND	ND	27.6

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.1.74
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 650 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aroclor-1254	7.7	NA	0.41	46	15.5	1.55	0.282	2.82	28.2	ND
Benzo(a)pyrene Equivalents	7.3	1	3.07	ND	ND	ND	0.297	2.97	29.7	ND
Copper	NA	NA	357	161346	53782	5378	ND	ND	ND	27.6

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

ıble 6.2.1.75
esidential-Based Remedial Goal Options
ıval Base Charleston, SWMU 9 Shallow Groundwater - First Quarter
ıarleston, South Carolina

emical	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1	Oral Reference Dose (mg/kg-day)	Inhalation Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
obenzene	0.11	0.108	ND	ND	0.0014	NA	NA	NA	0.000007	0.000075	0.00075	NA	NA
ılorobenzene	ND	ND	0.02	0.00571	0.12	0.0069	0.069	0.21	NA	NA	NA	NA	NA
ıromium (trivalent)	ND	ND	1	1	0.024	1.56	15.6	47	NA	NA	NA	0.1	NA
ı-Dichlorobenzene	0.024	0.024	0.229	0.229	0.0027	0.179	1.79	5.37	0.0014	0.014	0.14	0.075	NA
:-Dichloroethane	0.091	0.091	ND	0.00286	0.0068	0.004	0.045	0.13	0.00036	0.0036	0.036	0.005	NA
:-Dichloroethene (total)	ND	ND	0.009	0.04	0.0078	0.011	0.115	0.34	NA	NA	NA	0.07	NA
timony	ND	ND	0.0004	0.0004	0.0089	0.0006	0.006	0.02	NA	NA	NA	0.006	NA
rium	ND	ND	0.07	0.07	0.84	0.110	1.10	3.29	NA	NA	NA	2	0.323
nzene	0.029	0.029	ND	0.00171	0.012	0.003	0.027	0.08	0.0011	0.0114	0.1144	0.005	NA
nzidine	230	235	0.003	0.003	0.030	0.005	0.047	0.14	0.00000030	0.0000030	0.000030	NA	NA
rbon disulfide	ND	ND	0.1	0.00286	0.012	0.004	0.043	0.13	NA	NA	NA	NA	NA
:HP	0.014	0.014	0.02	0.02	0.0016	0.031	0.313	0.94	0.0047	0.047	0.47	NA	NA
pper	ND	ND	0.0371	0.0371	0.017	0.058	0.580	1.74	NA	NA	NA	1.3 (TTAL)	NA
ı-Dimethylphenol	ND	ND	0.02	0.02	0.050	0.031	0.313	0.94	NA	NA	NA	NA	NA
,7,8-TCDD equivalents	150000	150000	ND	ND	2.80E-09	NA	NA	NA	4.42E-10	4.42E-09	4.42E-08	3E-06	NA
ıylbenzene	ND	ND	0.1	0.286	0.025	0.116	1.16	3.48	NA	NA	NA	0.7	NA
(2-Chloroethyl)ether	1.1	1.16	ND	ND	0.012	NA	NA	NA	0.000029	0.00029	0.0029	NA	NA
xachlorocyclopentadiene	ND	ND	0.007	2E-05	0.0060	0.00003	0.0003	0.0009	NA	NA	NA	0.05	NA
ıd	ND	ND	ND	ND	0.017	NA	NA	NA	NA	NA	NA	0.015 (TTAL)	0.0047
lethylphenol	ND	ND	0.05	0.05	0.0091	0.078	0.78	2.35	NA	NA	NA	NA	NA
lethylphenol	ND	ND	0.005	0.005	0.068	0.008	0.08	0.23	NA	NA	NA	NA	NA
ıtachlorophenol	0.12	0.12	0.03	0.03	0.0019	0.047	0.47	1.41	0.00055	0.0055	0.055	0.001	NA
ıadium	ND	ND	0.007	0.007	0.011	0.011	0.11	0.33	NA	NA	NA	NA	NA
yl chloride	1.9	0.3	ND	ND	0.028	NA	NA	NA	0.00003	0.0003	0.003	0.002	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
TTAL treatment technique action level

le 6.2.1.76
rker-Based Remedial Goal Options
al Base Charleston, SWMU 9 Shallow Groundwater - First Quarter
rleston, South Carolina

mical	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1	Oral Reference Dose (mg/kg-day)	Inhalation Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
benzene	0.11	0.108	ND	ND	0.0014	NA	NA	NA	0.000023	0.00023	0.0023	NA	NA
robenzene	ND	ND	0.02	0.00571	0.117	0.045	0.45	4.5	NA	NA	NA	NA	NA
omium (trivalent)	ND	ND	1	1	0.024	10.2	102	1022	NA	NA	NA	0.1	NA
Dichlorobenzene	0.024	0.024	0.229	0.229	0.0027	1.17	11.7	117	0.0043	0.043	0.43	0.075	NA
Dichloroethane	0.091	0.091	ND	0.00286	0.0068	0.029	0.29	2.9	0.0011	0.0114	0.1142	0.005	NA
Dichloroethene (total)	ND	ND	0.009	0.04	0.0078	0.075	0.75	7.5	NA	NA	NA	0.07	NA
mony	ND	ND	0.0004	0.0004	0.0089	0.0041	0.041	0.41	NA	NA	NA	0.006	NA
um	ND	ND	0.07	0.07	0.84	0.715	7.15	71.5	NA	NA	NA	2	0.323
zene	0.029	0.029	ND	0.00171	0.012	0.0175	0.1748	1.7476	0.0036	0.036	0.36	0.005	NA
zidine	230	235	0.003	0.003	0.030	0.0307	0.307	3.07	0.00000092	0.0000092	0.000092	NA	NA
oon disulfide	ND	ND	0.1	0.00286	0.012	0.0284	0.284	2.84	NA	NA	NA	NA	NA
IP	0.014	0.014	0.02	0.02	0.0016	0.2044	2.04	20.4	0.0148	0.148	1.48	NA	NA
per	ND	ND	0.0371	0.0371	0.017	0.38	3.792	37.92	NA	NA	NA	1.3 (TTAL)	NA
Dimethylphenol	ND	ND	0.02	0.02	0.050	0.20	2.0	20	NA	NA	NA	NA	NA
7,8-TCDD equivalents	150000	150000	ND	ND	0.0000000028	NA	NA	NA	0.0000000014	0.000000014	0.00000014	3E-06	NA
lbenzene	ND	ND	0.1	0.286	0.025	0.7572	7.5723	75.7233	NA	NA	NA	0.7	NA
2-Chloroethyl)ether	1.1	1.16	ND	ND	0.012	NA	NA	NA	0.0001	0.0009	0.0092	NA	NA
achlorocyclopentadiene	ND	ND	0.007	2E-05	0.0060	0.0002	0.0020	0.0204	NA	NA	NA	0.05	NA
d	ND	ND	ND	ND	0.017	NA	NA	NA	NA	NA	NA	0.015 (TTAL)	0.0047
ethylphenol	ND	ND	0.05	0.05	0.0091	0.51	5.1	51	NA	NA	NA	NA	NA
ethylphenol	ND	ND	0.005	0.005	0.068	0.051	0.51	5.1	NA	NA	NA	NA	NA
tachlorophenol	0.12	0.12	0.03	0.03	0.0019	0.3	3.1	31	0.0017	0.0173	0.1731	0.001	NA
adium	ND	ND	0.007	0.007	0.011	0.072	0.72	7.154	NA	NA	NA	NA	NA
l chloride	1.9	0.3	ND	ND	0.028	NA	NA	NA	0.00009	0.0009	0.0094	0.002	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
TTAL treatment technique action level

able 6.2.1.77
esidential-Based Remedial Goal Options
aval Base Charleston, SWMU 9 Shallow Groundwater - Second Quarter
harleston, South Carolina

hemical	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1	Oral Reference Dose (mg/kg-day)	Inhalation Reference Dose (mg/kg-day)	Unadjuste EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
hlorobenzene	ND	ND	0.02	0.00571	0.115	0.007	0.07	0.21	NA	NA	NA	NA	NA
4-Dichlorobenzene	0.024	0.024	0.229	0.229	0.004	0.18	1.79	5.37	0.0014	0.014	0.14	0.075	NA
2-Dichloroethane	0.091	0.091	ND	0.00286	0.007	0.0045	0.04	0.13	0.0004	0.0036	0.04	0.005	NA
2-Dichloroethene (total)	ND	ND	0.009	0.04	0.012	0.011	0.11	0.34	NA	NA	NA	0.07	NA
ethylene chloride	0.0075	0.00164	0.06	0.857	0.015	0.09	0.88	2.63	0.0073	0.0726	0.73	0.005	NA
ichloroethene	0.011	0.006	0.006	0.0571	0.003	0.008	0.085	0.25	0.0039	0.0390	0.39	0.005	NA
eryllium	4.3	0.006	0.005	0.0571	0.000	0.008	0.078	0.23	0.000015	0.00015	0.0015	0.004	NA
rsenic	1.5	1.5	0.0003	0.0003	0.034	0.0005	0.005	0.014	0.000044	0.00044	0.0044	0.05	0.02799
arium	ND	ND	0.07	0.07	1.035	0.11	1.10	3.29	NA	NA	NA	2	0.323
enzene	0.029	0.029	ND	0.00171	0.011	0.0027	0.03	0.08	0.0011	0.0114	0.11	0.005	NA
admium	ND	ND	0.0005	0.0005	0.001	0.0008	0.008	0.02	NA	NA	NA	0.005	NA
opper	ND	ND	0.0371	0.0371	0.014	0.058	0.58	1.74	NA	NA	NA	1.3 (TTAL)	NA
4-Dimethylphenol	ND	ND	0.02	0.02	0.039	0.031	0.31	0.94	NA	NA	NA	NA	NA
exachlorobenzene	1.6	1.61	0.0008	0.0008	0.012	0.0006	0.006	0.02	0.00002	0.0002	0.002	0.001	NA
exachlorobutadiene	0.078	0.077	0.0002	0.0002	0.002	0.0002	0.0016	0.005	0.0004	0.0043	0.04	NA	NA
exachloroethane	0.014	0.014	0.001	0.001	0.002	0.0008	0.0078	0.02	0.0024	0.0237	0.24	NA	NA
ad	ND	ND	ND	ND	0.006	NA	NA	NA	NA	NA	NA	0.015 (TTAL)	0.0047
Methylphenol	ND	ND	0.005	0.005	0.040	0.0078	0.08	0.23	NA	NA	NA	NA	NA
nadium	ND	ND	0.007	0.007	0.009	0.01	0.11	0.33	NA	NA	NA	NA	NA
nyl chloride	1.9	0.3	ND	ND	0.027	NA	NA	NA	0.00003	0.0003	0.003	0.002	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
TTAL treatment technique action level

le 6.2.1.78
rker-Based Remedial Goal Options
al Base Charleston, SWMU 9 Shallow Groundwater - Second Quarter
rleston, South Carolina

mical	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1	Oral Reference Dose (mg/kg-day)	Inhalation Reference Dose (mg/kg-day)	Unadjuste EPC mg/l	Hazard-Based Remedial Goal Options 0.10 mg/l	1.00 mg/l	10.00 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
orobenzene	ND	ND	0.02	0.00571	0.115	0.05	0.45	4.54	NA	NA	NA	NA	NA
-Dichlorobenzene	0.024	0.024	0.229	0.229	0.004	1.17	11.70	117.02	0.004	0.043	0.43	0.075	NA
-Dichloroethane	0.091	0.091	ND	0.00286	0.007	0.03	0.29	2.92	0.0011	0.011	0.11	0.005	NA
-Dichloroethene (total)	ND	ND	0.009	0.04	0.012	0.08	0.75	7.51	NA	NA	NA	0.07	NA
hylene chloride	0.0075	0.00164	0.06	0.857	0.015	0.57	5.73	57.31	0.023	0.23	2.3	0.005	NA
hloroethene	0.011	0.006	0.006	0.0571	0.003	0.06	0.55	5.55	0.012	0.122	1.22	0.005	NA
yllium	4.3	0.006	0.005	0.0571	0.000	0.05	0.51	5.11	0.00005	0.00048	0.005	0.004	NA
enic	1.5	1.5	0.0003	0.0003	0.034	0.00	0.03	0.31	0.00014	0.0014	0.014	0.05	0.02799
ium	ND	ND	0.07	0.07	1.035	0.72	7.15	71.54	NA	NA	NA	2	0.323
zene	0.029	0.029	ND	0.00171	0.011	0.02	0.17	1.75	0.004	0.036	0.358	0.005	NA
lmium	ND	ND	0.0005	0.0005	0.001	0.01	0.05	0.51	NA	NA	NA	0.005	NA
per	ND	ND	0.0371	0.0371	0.014	0.38	3.79	37.92	NA	NA	NA	1.3 (TTAL)	NA
-Dimethylphenol	ND	ND	0.02	0.02	0.039	0.20	2.04	20.44	NA	NA	NA	NA	NA
achlorobenzene	1.6	1.61	0.0008	0.0008	0.012	0.00	0.04	0.41	0.00006	0.0006	0.006	0.001	NA
achlorobutadiene	0.078	0.077	0.0002	0.0002	0.002	0.00	0.01	0.10	0.0013	0.013	0.134	NA	NA
achloroethane	0.014	0.014	0.001	0.001	0.002	0.01	0.05	0.51	0.007	0.074	0.742	NA	NA
d	ND	ND	ND	ND	0.006	NA	NA	NA	NA	NA	NA	0.015 (TTAL)	0.0047
ethylphenol	ND	ND	0.005	0.005	0.040	0.05	0.51	5.11	NA	NA	NA	NA	NA
adium	ND	ND	0.007	0.007	0.009	0.07	0.72	7.15	NA	NA	NA	NA	NA
/l chloride	1.9	0.3	ND	ND	0.027	NA	NA	NA	0.00009	0.0009	0.009	0.002	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
TTAL treatment technique action level

ble 6.2.1.79
sidential-Based Remedial Goal Options
val Base Charleston, SWMU 9 Deep Groundwater - First Quarter
arleston, South Carolina

emical	Oral Slope Factor (mg/kg-day)-	Inhalation Slope Factor (mg/kg-day)-	Oral Reference Dose (mg/kg-day	Inhalation Reference Dose (mg/kg-day	Unadjuste EPC mg/l	**Hazard-Based Remedial Goal Options** **0.1** mg/l	**1.0** mg/l	**3** mg/l	**Risk-Based Remedial Goal Options** **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	Background Concentration mg/l
romium (trivalent)	ND	ND	1	1	0.018	1.564	15.64	46.9	NA	NA	NA	0.1	NA
dmium	ND	ND	0.0005	0.0005	0.0022	0.0008	0.008	0.023	NA	NA	NA	0.005	NA
rbon disulfide	ND	ND	0.1	0.00286	0.061	0.0043	0.043	0.13	NA	NA	NA	NA	NA
loroform	0.0061	0.0805	0.01	0.01	0.0024	0.0078	0.078	0.23	0.001	0.008	0.077	0.1	NA
nganese	ND	ND	0.005	0.005	0.8	0.0078	0.078	0.23	NA	NA	NA	NA	6.085
allium	ND	ND	8E-05	8E-05	0.16	0.00013	0.0013	0.004	NA	NA	NA	0.002	0.00766

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
TTAL treatment technique action level

le 6.2.1.80
rker-Based Remedial Goal Options
ral Base Charleston, SWMU 9 Deep Groundwater - First Quarter
rleston, South Carolina

mical	Oral Slope Factor (mg/kg-day)-	Inhalation Slope Factor (mg/kg-day)-	Oral Reference Dose (mg/kg-day	Inhalation Reference Dose (mg/kg-day	Unadjuste EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
omium (trivalent)	ND	ND	1	1	0.0181	10.2	102	307	NA	NA	NA	0.1	NA
lmium	ND	ND	0.0005	0.0005	0.0022	0.005	0.051	0.15	NA	NA	NA	0.005	NA
bon disulfide	ND	ND	0.1	0.00286	0.061	0.028	0.284	0.85	NA	NA	NA	NA	NA
oroform	0.0061	0.0805	0.01	0.01	0.0024	0.051	0.51	1.53	0.002	0.024	0.24	0.1	NA
nganese	ND	ND	0.005	0.005	0.805	0.051	0.51	1.53	NA	NA	NA	NA	6.085
llium	ND	ND	8E-05	8E-05	0.16	0.001	0.008	0.025	NA	NA	NA	0.002	0.00766

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
TTAL treatment technique action level

able 6.2.1.81
esidential-Based Remedial Goal Options
aval Base Charleston, SWMU 9 Deep Groundwater - Second Quarter
harleston, South Carolina

hemical	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1	Oral Reference Dose (mg/kg-day)	Inhalation Reference Dose (mg/kg-day)	Unadjuste EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
admium	ND	ND	0.0005	0.0005	0.0032	0.00078	0.0078	0.023	NA	NA	NA	0.005	NA
anganese	ND	ND	0.005	0.005	1.27	0.0078	0.078	0.23	NA	NA	NA	NA	6.085

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

le 6.2.1.82
rker-Based Remedial Goal Options
al Base Charleston, SWMU 9 Deep Groundwater - Second Quarter
rleston, South Carolina

mical	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1	Oral Reference Dose (mg/kg-day)	Inhalation Reference Dose (mg/kg-day)	Unadjuste EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
dmium	ND	ND	0.0005	0.0005	0.0032	0.0051	0.051	0.15	NA	NA	NA	0.005	NA
nganese	ND	ND	0.005	0.005	1.27	0.051	0.51	1.5	NA	NA	NA	NA	6.085

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.1.14
AOC 649
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Acetone	UG/KG	1/ 5	19.80 - 34.00	25.200 - 25.200	25.200	780000.0000			
Acrylonitrile	UG/KG	1/ 1		5.800 - 5.800	5.800	1200.0000			
Aluminum	MG/KG	10/ 10		2330.000 - 10900.000	5038.000	7800.0000	2	25310.000	
Anthracene	UG/KG	1/ 10	330.00 - 470.00	77.900 - 77.900	77.900	2300000.0000			
Antimony	MG/KG	2/ 10	0.81 - 1.30	1.300 - 1.600	1.450	3.1000			
Aroclor-1248	UG/KG	1/ 10	40.00 - 83.00	52.000 - 52.000	52.000	83.0000			
Aroclor-1254	UG/KG	2/ 10	40.00 - 83.00	30.000 - 62.000	46.000	83.0000			
Arsenic	MG/KG	5/ 10	0.65 - 9.10	2.700 - 9.500	6.170	0.3700	5	14.810	
Barium	MG/KG	5/ 10	6.30 - 35.10	20.200 - 41.700	27.860	550.0000		40.330	1
Benzo(g,h,i)perylene	UG/KG	2/ 10	420.00 - 470.00	94.300 - 216.000	155.150	310000.0000			
* Benzo(a)pyrene Equivalents	UG/KG	10/ 10		91.525 - 403.288	143.712	88.0000	10		
Benzo(a)anthracene	UG/KG	4/ 10	420.00 - 460.00	99.100 - 253.000	151.275				
Benzo(b)fluoranthene	UG/KG	4/ 10	420.00 - 460.00	130.000 - 464.000	232.500				
Chrysene	UG/KG	5/ 10	420.00 - 450.00	60.600 - 273.000	155.520				
Dibenzo(a,h)anthracene	UG/KG	1/ 10	330.00 - 470.00	72.100 - 72.100	72.100				
Indeno(1,2,3-cd)pyrene	UG/KG	2/ 10	420.00 - 470.00	62.500 - 198.000	130.250				
Benzo(k)fluoranthene	UG/KG	2/ 10	410.00 - 460.00	83.100 - 130.000	106.550				
Benzo(a)pyrene	UG/KG	4/ 10	420.00 - 460.00	80.900 - 239.000	129.550				
Benzoic acid	UG/KG	2/ 10	1800.00 - 2300.00	76.900 - 87.700	82.300	31000000.0000			
Beryllium	MG/KG	10/ 10		0.080 - 0.550	0.259	0.1500	6	1.470	
Butylbenzylphthalate	UG/KG	2/ 10	410.00 - 470.00	63.100 - 97.400	80.250	1600000.0000			
Cadmium	MG/KG	6/ 10	0.10 - 0.15	0.150 - 0.280	0.223	3.9000		1.050	
Calcium	MG/KG	10/ 10		717.000 - 43600.000	12204.700				
Carbon disulfide	UG/KG	1/ 5	6.10 - 6.90	4.800 - 4.800	4.800	780000.0000			
alpha-Chlordane	UG/KG	4/ 10	4.00 - 4.00	3.000 - 7.000	4.650	470.0000			
Chlorobenzene	UG/KG	1/ 5	6.10 - 6.90	1.800 - 1.800	1.800	160000.0000			
Chromium	MG/KG	10/ 10		4.500 - 17.400	9.830	39.0000		85.650	
Cobalt	MG/KG	10/ 10		0.820 - 3.200	1.782	470.0000		5.860	
Copper	MG/KG	7/ 10	1.10 - 15.20	6.700 - 112.100	43.228	290.0000		27.600	3
4,4'-DDD	UG/KG	1/ 10	6.90 - 9.00	8.000 - 8.000	8.000	2700.0000			
4,4'-DDE	UG/KG	3/ 10	3.80 - 4.60	6.000 - 10.200	8.400	1900.0000			
Dibenzofuran	UG/KG	1/ 10	330.00 - 470.00	56.500 - 56.500	56.500	31000.0000			
Di-n-butylphthalate	UG/KG	5/ 10	430.00 - 470.00	68.900 - 99.100	78.440	780000.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1		8.381 - 8.381	8.381	1000.0000			

Table 6.2.1.14
AOC 649
Surface Soil

	Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
	bis(2-Ethylhexyl)phthalate	UG/KG	2/ 10	410.00 -	470.00	107.000 -	180.000	143.500	46000.0000			
	Fluoranthene	UG/KG	4/ 10	420.00 -	460.00	208.000 -	586.000	308.500	310000.0000			
	Iron	MG/KG	10/ 10			1800.000 -	12900.000	5105.000			30910.000	
	Lead	MG/KG	10/ 10			3.600 -	113.200	33.690	400.0000j		118.000	
	Magnesium	MG/KG	10/ 10			104.000 -	1420.000	495.300			9592.000	
	Manganese	MG/KG	10/ 10			6.300 -	124.000	36.910	39.0000	3	636.400	
*	Mercury	MG/KG	6/ 10	0.02 -	0.03	0.040 -	6.900	1.235	2.3000	1	0.490	1
	2-Methylnaphthalene	UG/KG	3/ 10	410.00 -	470.00	99.100 -	183.000	133.083	310000.0000i			
	Naphthalene	UG/KG	3/ 10	410.00 -	470.00	66.500 -	102.000	79.633	310000.0000			
	Nickel	MG/KG	10/ 10			0.930 -	13.150	5.568	160.0000		33.380	
	Phenanthrene	UG/KG	6/ 10	430.00 -	450.00	65.500 -	395.000	194.916	310000.0000k			
	Potassium	MG/KG	6/ 10	136.00 -	309.00	95.200 -	729.000	328.033				
	Pyrene	UG/KG	4/ 10	420.00 -	460.00	180.000 -	480.000	260.750	230000.0000			
	Selenium	MG/KG	3/ 10	0.21 -	0.36	0.220 -	0.370	0.286	39.0000		2.000	
	Sodium	MG/KG	9/ 10	26.30 -	26.30	35.100 -	140.000	72.977				
*	Petroleum Hydrocarbons, TPH	MG/KG	1/ 1			160.000 -	160.000	160.000	10.0000	1		
	Tin	MG/KG	1/ 1			22.300 -	22.300	22.300	4700.0000			
	Toluene	UG/KG	2/ 5	6.10 -	6.90	3.110 -	4.900	4.005	1600000.0000			
	Vanadium	MG/KG	10/ 10			5.300 -	35.400	13.355	55.0000		77.380	
	Xylene (total)	UG/KG	1/ 5	6.10 -	6.90	7.100 -	7.100	7.100	16000000.0000			
	Zinc	MG/KG	10/ 10			6.000 -	281.000	93.840	2300.0000		214.300	1

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

6.2.2 Baseline Risk Assessment for SWMU 13

6.2.2.1 Site Background and Investigative Approach

SWMU 13 was investigated to assess soil and groundwater potentially affected by site activities. SWMU 13 is a firefighting training area, at the northern boundary of Zone H. It includes buildings 204, 1303, 1306, 1309, 1310, 1313, 1744, and 1834, and several other structures. It is used to train personnel in firefighting techniques. Diesel fuel and gasoline are ignited in controlled burns in a contained, paved, and bermed area. Water and fuel drain into oil-water separators which discharge into the sewer system. Recovered petroleum products are recycled. A UST is in the northwest portion of the site.

Thirty-one surface soil samples from 28 locations were collected and analyzed from SWMU 13. Table 6.2.2.1 shows each surface soil sample location and lists the analytical methods used for each sample. First- and second-quarter groundwater samples were collected from nine shallow monitoring wells and analyzed for parameters similar to those for soil samples, as shown in Tables 6.2.2.2 and 6.2.2.3, respectively.

6.2.2.2 COPC Identification

Soil

As shown in Table 6.2.2.4, this HHRA focuses on the following COPCs for soil: cPAHs (as BEQs) and heptachlor. The results of the Wilcoxon rank sum test background comparisons of inorganic CPSSs that exceeded their corresponding risk-based screening values did not identify any additional COPCs. Therefore, the soil COPCs listed above were formally assessed. Petroleum hydrocarbons were identified in 10 of 23 surface soil samples reported at concentrations ranging between 75 and 730 mg/kg. Concentrations reported at five locations exceeded the 100 mg/kg TPH AL established for NAVBASE soil.

Groundwater

As shown in Table 6.2.2.5, no groundwater COPCs were identified at this site based on first-quarter groundwater monitoring results. Table 6.2.2.6 shows COPCs identified based on the second-quarter groundwater monitoring effort at SWMU 13. The Wilcoxon rank sum comparison for SWMU 13 indicated potassium concentrations were above background. Beryllium is the only groundwater COPC identified based on second-quarter groundwater monitoring data.

6.2.2.3 Exposure Assessment

Exposure Setting

The exposure setting at SWMU 13 is a firefighting training area. The mostly paved site is at the northern boundary of Zone H. The future use of this site is unknown although current plans indicate it will be a cargo terminal.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers and hypothetical future site residents. The current site users consist of firefighting trainees and instructors who use the area infrequently and for a short duration. The hypothetical future site worker scenario assumed site workers were continuously exposed to surface soil. A current site user's exposure would be less than that assumed for the hypothetical future site worker scenario because limited frequency of soil contact. The hypothetical site resident scenario was also included. Exposure projections (and resultant RGOs) for the future site worker will conservatively assess RME under current site use conditions.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of surface soil. The exposure pathways under the hypothetical future residential land use are the same as those for the future site worker. Uniform exposure was assumed for all sample locations. In addition, the future site worker scenario assumed continuous exposure to surface soil conditions. Groundwater was formally assessed for the site worker and hypothetical site resident ingestion pathway. Table 6.2.2.7 justifies exposure pathways assessed in this HHRA.

Exposure Point Concentrations

More than 10 surface soil samples were analyzed; therefore, UCLs were calculated, and the lesser of the maximum reported concentrations or the calculated UCLs was used as the EPC for each COPC in Table 6.2.2.8. Because there are fewer than 10 groundwater monitoring wells at SWMU 13, the maximum concentration reported for groundwater COPCs was used as the EPC for the groundwater pathway.

Soil

Table 6.2.2.8 presents the EPCs used in this HHRA for SWMU 13. Tables 6.2.2.9 and 6.2.2.10 present the CDIs calculated for the incidental ingestion and dermal contact exposure pathways, respectively.

Groundwater

Table 6.2.2.11 presents exposure estimates for ingestion of shallow groundwater.

6.2.2.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.4 of this report. Toxicological risk information is summarized in Table 6.2.2.12, and toxicological profiles are presented below for COPCs identified in Section 6.2.2.2.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1

Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the BAP is classified B2 based on insufficient human data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question, the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and is presented as the switching per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is based on data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells and transformed mammalian cells in culture. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene***. USEPA determined RfDs for only two of these compounds: pyrene's RfD_o is 0.03 mg/kg-day, and this RfD is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

Heptachlor is an insecticide which was used to control flies, mosquitoes, and field insects (Dreisbach et al., 1987). USEPA determined this compound to be a class B2 carcinogen, and determined the SF_o to be 4.5 $(mg/kg\text{-}day)^{-1}$. As listed in IRIS (search date 6/29/95), the classification is based on inadequate human data, but sufficient evidence exists from studies in which benign and malignant liver tumors were induced in three strains of mice of both sexes. Several structurally related compounds are liver carcinogens. The primary target organs for this pesticide are the liver and kidneys, and USEPA determined the RfD_o to be 0.0005 mg/kg-day. As listed in IRIS, the critical effect of this chemical is liver weight increases in males. The uncertainty factor was 300 and the modifying factor was 1.

Beryllium exposure via the inhalation route can inflame the lungs, a condition known as acute beryllium disease, as a result of short-term exposure to high concentrations. Removal from exposure reverses the symptoms. Chronic exposure to much lower concentrations of beryllium or beryllium oxide by inhalation has been reported to cause chronic beryllium disease, with symptoms including shortness of breath, scarring of the lungs, and berylliosis, which is noncancerous growths in the lungs of humans. Both forms of beryllium disease can be fatal, depending on the severity of the exposure. Additionally, a skin allergy may develop when soluble beryllium compounds come into contact with the skin of sensitized individuals (Gradient, 1991). An oral RfD of 0.0054 mg/kg-day has been set for beryllium based on a chronic oral bioassay (rats were the study species) which determined no adverse effect occurs at 0.54 mg/kg-day. Beryllium has been classified by USEPA as a group B2 carcinogen based on animal studies. It has been shown to induce lung cancer via inhalation in rats and monkeys, and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. Human epidemiology studies of beryllium are considered to be inadequate. As listed in IRIS (search date 6/28/95), beryllium has been shown to induce lung cancer via inhalation in rats and monkeys and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. Human epidemiology studies are inadequate. USEPA set an inhalation SF of 8.4 $(mg/kg\text{-}day)^{-1}$ and an oral SF of 4.3 $(mg/kg\text{-}day)^{-1}$. As listed in IRIS, of this chemical has no adverse critical effect. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfD in drinking water is 0.005 mg/kg-day.

Naphthalene, as well as ***2-methylnaphthalene***, are obtained from coal tar and are used as a moth repellant and as a synthetic intermediate. The primary effect of naphthalene is on the kidneys due to this compound's effect on the blood (Dreisbach et al., 1987). Naphthalene was determined to be a USEPA class D carcinogen (i.e., is not classified due to insufficient data). As listed in IRIS (search date 11/22/95), the classification is based on no human data and inadequate data from animal bioassays. Results from the National Toxicology Program (NTP), a two-year cancer bioassay (1991), suggest that naphthalene may be more appropriately classified as a possible human carcinogen (Group C under current USEPA guidelines). The NTP concluded, "Under the conditions of these two-year studies, there is no evidence of carcinogenic activity of naphthalene in male B6C3F1 mice exposed by inhalation to concentrations of 10 or 30 ppm for six hours daily, five days per week, for 103 weeks. There was some evidence of carcinogenic activity of naphthalene in female B6C3F1 mice, as indicated by the increased incidences of pulmonary alveolar/bronchiolar adenomas." USEPA determined the RfD_o to be 0.04 mg/kg-day, which was withdrawn from IRIS/HEAST.

The Wilcoxon rank sum comparison for SWMU 13 potassium concentrations indicated onsite potassium concentrations are elevated with respect to background. Magnesium, potassium, iron, calcium, and sodium are all essential nutrients. These elements were eliminated from formal assessment because they are essential elements. These nutrients would be expected to be indigenous to the soil. In vitamin supplements, 100, 40, 18, and 162 mg are the daily doses for magnesium, potassium, iron, and calcium, and approximately 70 mg of sodium is found in the typical soda.

6.2.2.5 Risk Characterization

Surface Soil

Exposure to surface soil onsite was analyzed under both residential and industrial (site worker) scenarios. For each scenario, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 6.2.2.13 and 6.2.2.14 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soil.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for SWMU 13 surface soil is 8E-7. The dermal pathway ILCR is 4E-7. Carcinogenic PAHs (as BEQs) were the primary contributor to ILCR for each pathway. Heptachlor accounted for approximately one order of magnitude less than the ILCR estimated for BEQs.

The computed HI for the adult resident was 0.00003 for the soil ingestion pathway. The computed HI for the child ingestion pathway was 0.0003. The dermal contact pathway HIs were 0.00003 and 0.00009 for both the adult resident and the child resident. The only contributor to hazard for either soil pathway was heptachlor.

Hypothetical Site Workers

Site worker ILCRs are 9E-8 and 2E-7 for the ingestion and dermal contact pathways, with cPAHs (as BEQs) as the primary contributor to ILCR for each pathway. Heptachlor accounted for approximately one order of magnitude less than the ILCR estimated for BEQs. The HIs for the ingestion and dermal pathways were 0.00001 and 0.00002 for the site worker scenario, and the sole contributor to the HIs was heptachlor.

The reported hits for BEQs were either from samples collected within 2 feet of an asphalt area or directly beneath the asphalt. PAHs are components of asphalt, and asphalt could contribute to the equivalent concentrations reported beneath or near the asphalt area. In addition, a fence currently prevents frequent trespass, and only workers engaged in short-term activities would be likely to enter the area.

Groundwater

Exposure to shallow groundwater was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion exposure was considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Table 6.2.2.15 presents the estimated carcinogenic risk and noncarcinogenic HQs associated with the potable use ingestion of shallow groundwater.

Future Site Residents

The projected ingestion-related ILCR from shallow groundwater was estimated to be 1E-5. The HIs for adult and child residential receptors were estimated to be 0.001 and 0.003, respectively. Beryllium was the sole contributor to both the ILCR and HIs, and was reported in only one monitoring well.

Future Site Workers

The projected ingestion related ILCR from shallow groundwater was 5E-6, and the site worker HI was estimated to be 0.0004. Beryllium was the sole contributor to both the ILCR and HIs.

Current Site Workers

Shallow groundwater is not currently a potable water source for SWMU 13 or other areas of Zone H. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and an HI threshold of 1.0 (unity). In Zone H HHRAs, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a cumulative HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is relatively conservative, because USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection algorithm provides a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process. The soil exposure scenarios were maintained in both instances. However, as described previously, the cumulative risk threshold used to identify COCs in this HHRA (1E-6) is two orders of magnitude more conservative.

Surface Soil

Hypothetical Site Residents (Future Land Use)

No risk- or hazard-based COCs were identified for the hypothetical site resident scenario.

Hypothetical Site Workers (Current Land Use)

No risk or hazard-based COCs were identified for the hypothetical site worker scenario.

Groundwater

Hypothetical Site Residents (Future Land Use)

Beryllium was identified as a COC for this scenario based on its contribution to risk/hazard.

Hypothetical Site Workers (future land use)

Beryllium was identified as a COC for this scenario based on its contribution to risk/hazard.

Due to the limited extent of identified shallow groundwater impacts, graphical presentation of risk projections for SWMU 13 groundwater was determined to be of limited use. Instead, the extent of the COC is briefly discussed below. Beryllium was detected in one second-quarter shallow groundwater sample. The third- and fourth-quarter results will confirm whether beryllium is present in shallow groundwater. This review will facilitate responsible and sound risk management decisions.

6.2.2.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site groundwater, and they are infrequently exposed to surface soil when walking across exposed soil at the site. Approximately 90% of the site is paved. Firefighter trainees would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year, as assumed in the exposure assessment, and the duration of training activities is much less than 25 years. Using the site for training drills 52 days per year would reduce exposure frequency 80% relative to the default site worker assumptions. In addition, less than eight hours per day are required to complete training drills. As a result, estimated exposure would be proportionately reduced.

Residential use of the site would not be expected, based on current site uses and the nature of the surrounding buildings. SWMU 13 is a firefighting training area. Current base reuse plans call for a cargo terminal. If this area were to be used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at SWMU 13 for potable or industrial purposes. A basewide system supplies drinking and process water to Zone H buildings. This system is to remain in operation under the current base reuse plan. As a result, shallow groundwater use would not be expected under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Based on the guidance provided by USEPA and discussed in Section 6.1.4.4 of this report, EPCs are used to estimate CDI. The uncertainty associated with EPCs primarily stems from their statistical determination (UCLs) or imposition of maximum concentrations.

Soil

BEQs reportedly exceeded the residential RBC at three sample locations: 013SB005, 013SB008, and 013SB017. Likewise, heptachlor concentrations reportedly exceeded the residential RBC at two sample locations, 013SB006 and 013SB019. EPCs at these locations are underestimates relative to the UCL. The UCL was calculated assuming sitewide exposure, as the data do not clearly define a hot spot.

Groundwater

Beryllium exposure was estimated using the maximum reported concentration, and therefore, risk is calculated based on the maximum reported concentration is likely an overestimate.

Frequency of Detection and Spatial Distribution

BEQs and heptachlor were detected in three of 23 and two of 23 surface soil samples analyzed for these compounds, respectively. The limited frequency of detection suggests that the compounds are not widespread at SWMU 13. BAP accounted for approximately 80% of the equivalent concentrations, and PAHs were reported in only three of 23 samples. By imposing the UCL, RME was estimated for this site. If the fraction ingested from contaminated source (based on the frequency of detection for each COPC) were considered in the exposure calculations at this site, the risk estimates for surface soil and groundwater would be significantly less. However, based on the distribution of the reported concentrations, no hot spot was clearly evident, and hot spot analysis was not performed.

TPH results reported in site soil (75 to 730 mg/kg) exceeded the NAVBASE soil threshold of 100 mg/kg. No groundwater sample contained detectable concentrations of TPH. The absence of TPH in groundwater indicates the shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of TPH constituents.

Beryllium was reported in only one of nine second-quarter groundwater samples analyzed, and the maximum concentration was used to estimate exposure. Imposing the maximum reported concentration overestimates exposure because low detection frequency compounds are not distributed equally across the site.

Quantification of Risk/Hazard

As indicated by the discussions above, uncertainty is inherent during the risk assessment process. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of variability and uncertainty are discussed below.

Soil

Of the CPSSs eliminated from formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Concentrations of aluminum, arsenic, beryllium, and manganese exceed their corresponding RBCs, but none of the maximum concentrations exceeds the corresponding reference concentration. Therefore, they were eliminated from formal assessment based on comparisons to the reference concentrations because they do not contribute to excess risk/hazard onsite.

Although future land use at this site is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely overestimate risk and/or hazard.

Groundwater

No COPCs were identified for this exposure pathway based on the first-quarter screening comparisons. However, 2-methylnaphthalene and beryllium were identified as COPCs based on second-quarter groundwater sampling. Of the CPSSs eliminated from formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration close to its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Manganese and arsenic concentrations exceed the corresponding RBCs, but these elements do not exceed the corresponding reference concentrations. Therefore, manganese and arsenic were eliminated from formal assessment based on comparison to the corresponding reference concentrations because they do not contribute to excess risk/hazard onsite.

As a measure of variability, CT analysis was performed for soil and groundwater. Exposure assumptions were modified to reflect the 50th percentile rather than the 95th, and EPCs were not modified. In accordance with *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure-Draft* (USEPA, November 1993), the exposure duration of site residents were reduced from 30 to nine years, two years for child exposure, and seven years for adult exposure. Exposure frequency was reduced from 350 to 234 for site residents and from 250 to 219 for site workers. The drinking water ingestion rate for an adult was reduced from 2 to 1.4 liters per day, and exposure to groundwater was reduced by 25% to account for other water sources. Based on CT, the shallow groundwater-related risk (incidental ingestion) would be approximately 2E-6, and the CT estimate for the worker would be 6E-7. HI estimates are below 1.0. Tables 6.2.2.16 and 6.2.2.17 present the CT CDI and risk/hazard for the ingestion of groundwater exposure pathway, respectively.

6.2.2.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 13 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion was evaluated for shallow groundwater based on first- and second-quarter groundwater monitoring data. Table 6.2.2.18 summarizes the risk summary for each pathway/receptor group evaluated for SWMU 13.

6.2.2.8 Remedial Goal Options

Soil

No COCs were identified for soil exposure pathways, and therefore, no RGOs were calculated.

Groundwater

RGOs were calculated for ingestion of shallow groundwater. RGOs calculated for the site resident and site worker are presented in Tables 6.2.2.19 and 6.2.2.20, respectively.

Table 6.2.2.1
Methods Run at SWMU 13
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Harb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
013	B001	S	S	S	Y					S	Y					
013	B002	S	S	S	Y					S	Y					
013	B003	S	S	S	Y					S	Y					
013	B004	S	S	S	Y					S	Y					
013	B005	S	S	S	Y					S	Y					
013	B006	B	B	B	Y	Y	Y	Y	A	B	B					
013	B007	S	S	S	Y					S	Y					
013	B008	S	S	S	Y					S	Y					
013	B009	S	S	S	Y					S	Y					
013	B010	S	S	S	Y					S	Y					
013	B011	S	S	S	Y					S	Y					
013	B012	S	S	S	Y					S	Y					
013	B013	S	S	S	Y					S	Y					
013	B014	S	S	S	Y					S	Y					
013	B015	S	S	S	Y					S	Y					
013	B016	S	S	S	Y					S	Y					
013	B017	S	S	S	Y					S	Y					
013	B018	S	S	S	Y					S	Y					
013	B019	S	S	S	Y					S	Y					
013	B020	S	S	S	Y					S	Y					
013	B021	B	B	B	Y	Y	Y	Y	A	B	B					
013	B022	B	B	B	Y	Y	Y	Y	A	B	B					
013	B023	S	S	S	Y					S	Y					
013	B024						Y									
013	B025						Y									
013	B026						Y									
013	B027						Y									
013	B028						Y									
013	B18A													Y	Y	Y
013	B19A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.2.2
Methods Run at SWMU 13
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
013	1301	S	S	S	Y					S	Y					
013	1302	S	S	S	Y					S	Y					
013	W001	S	S	S	Y					S	Y					
013	W002	S	S	S	Y					S	Y					
013	W003	S	S	S	Y					S	Y					
013	W004	S	S	S	Y					S	Y					
013	W005	S	S	S	Y					S	Y					
013	W006	S	S	S	Y					S	Y					
013	W007	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
		Tph:	Total Petroleum Hydrocarbons: Method 418.1
VOA:	Volatile Organics: Method 8240	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
SVOA:	Semi-volatile Organics: Method 8270		
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.2.3
Methods Run at SWMU 13
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
013	1301	S	S							S						
013	1302	S	S							S						
013	W001	S	S							S						
013	W002	S	S							S						
013	W003	S	S							S						
013	W004	S	S							S						
013	W005	S	S							S						
013	W006	S	S							S						
013	W007	S	S							S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.2.4
SWMU 13
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	18/ 23	18.80 - 29.00	25.000 - 190.000	89.888	780000.0000			
Aluminum	MG/KG	23/ 23		554.000 - 11300.000	3270.782	7800.0000	1	25310.000	
Antimony	MG/KG	1/ 23	0.98 - 14.30	1.900 - 1.900	1.900	3.1000			
Arsenic	MG/KG	11/ 23	0.96 - 6.00	1.600 - 5.600	3.495	0.3700	11	14.810	
beta-BHC	UG/KG	2/ 23	1.70 - 40.00	1.500 - 19.500	10.500	350.0000			
alpha-BHC	UG/KG	1/ 23	1.70 - 40.00	1.000 - 1.000	1.000	100.0000			
Barium	MG/KG	10/ 23	0.99 - 21.90	1.900 - 36.400	13.845	550.0000		40.330	
* Benzo(a)pyrene Equivalents	UG/KG	23/ 23		54.725 - 122.090	60.277	88.0000	2		
Benzo(a)anthracene	UG/KG	2/ 23	330.00 - 540.00	110.000 - 120.000	115.000				
Benzo(b)fluoranthene	UG/KG	3/ 23	330.00 - 540.00	65.000 - 130.000	94.666				
Chrysene	UG/KG	2/ 23	46.00 - 540.00	110.000 - 140.000	125.000				
Benzo(k)fluoranthene	UG/KG	2/ 23	330.00 - 540.00	84.000 - 95.000	89.500				
Benzo(a)pyrene	UG/KG	2/ 23	330.00 - 540.00	91.000 - 96.000	93.500				
Beryllium	MG/KG	4/ 23	0.10 - 1.30	0.180 - 0.670	0.328	0.1500	4	1.470	
2-Butanone (MEK)	UG/KG	2/ 23	10.00 - 50.00	13.000 - 23.000	18.000	4700000.0000			
Cadmium	MG/KG	3/ 23	0.14 - 1.80	0.160 - 0.190	0.176	3.9000		1.050	
Calcium	MG/KG	23/ 23		3000.000 - 312000.000	29293.478				
alpha-Chlordane	UG/KG	5/ 23	1.70 - 40.00	1.400 - 69.000	19.120	470.0000			
gamma-Chlordane	UG/KG	5/ 23	1.70 - 40.00	1.500 - 160.000	42.580	470.0000			
Chromium	MG/KG	23/ 23		2.700 - 19.700	10.189	39.0000		85.650	
Cobalt	MG/KG	7/ 23	0.59 - 4.90	0.825 - 3.300	1.525	470.0000		5.860	
Copper	MG/KG	14/ 23	0.25 - 5.90	1.700 - 49.900	12.682	290.0000		27.600	1
Cyanide	MG/KG	2/ 23	0.80 - 1.00	1.000 - 5.500	3.250	160.0000			
4,4'-DDD	UG/KG	5/ 23	3.30 - 40.00	5.000 - 250.000	57.820	2700.0000			
4,4'-DDE	UG/KG	18/ 23	3.70 - 5.00	3.000 - 380.000	42.862	1900.0000			
4,4'-DDT	UG/KG	4/ 23	3.30 - 40.00	7.000 - 152.500	58.625	1900.0000			
Di-n-butylphthalate	UG/KG	1/ 23	330.00 - 540.00	180.000 - 180.000	180.000	780000.0000			
Diethylphthalate	UG/KG	1/ 23	330.00 - 540.00	56.000 - 56.000	56.000	6300000.0000			
Dioxin (TCDD TEQ)	PG/G	8/ 8		1.029 - 427.720	69.278	1000.0000			
Endosulfan II	UG/KG	1/ 23	3.30 - 80.00	5.100 - 5.100	5.100	47000.0000			
Endrin aldehyde	UG/KG	1/ 23	3.30 - 80.00	3.400 - 3.400	3.400	2300.0000h			
Fluoranthene	UG/KG	4/ 23	330.00 - 540.00	47.000 - 290.000	156.750	310000.0000			
* Heptachlor	UG/KG	2/ 23	1.70 - 40.00	5.300 - 390.000	197.650	140.0000	1		
Heptachlor epoxide	UG/KG	5/ 23	1.70 - 40.00	4.000 - 23.000	12.140	70.0000			

Table 6.2.2.4
SWMU 13
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Hexachlorocyclopentadiene	UG/KG	1/ 23	330.00 - 540.00	430.000 - 430.000	430.000	55000.0000			
Iron	MG/KG	23/ 23		1550.000 - 16400.000	5344.782			30910.000	
Lead	MG/KG	12/ 23	2.00 - 23.10	5.900 - 84.700	31.100	400.0000j		118.000	
Magnesium	MG/KG	23/ 23		213.000 - 2780.000	921.391			9592.000	
Manganese	MG/KG	23/ 23		21.900 - 218.000	76.152	39.0000	21	636.400	
Mercury	MG/KG	4/ 23	0.02 - 0.04	0.030 - 0.080	0.052	2.3000		0.490	
Nickel	MG/KG	9/ 23	0.76 - 7.70	1.400 - 22.100	6.938	160.0000		33.380	
Phenanthrene	UG/KG	3/ 23	330.00 - 540.00	130.000 - 240.000	166.666	310000.0000k			
Potassium	MG/KG	5/ 23	132.00 - 689.00	180.000 - 1040.000	543.800				
Pyrene	UG/KG	5/ 23	330.00 - 540.00	55.000 - 230.000	117.600	230000.0000			
Selenium	MG/KG	1/ 23	0.06 - 2.40	0.600 - 0.600	0.600	39.0000		2.000	
Sodium	MG/KG	22/ 23	47.10 - 47.10	61.900 - 414.000	154.681				
2,4,5-T	UG/KG	1/ 3	10.00 - 10.00	7.700 - 7.700	7.700	78000.0000			
2,4,5-TP (Silvex)	UG/KG	2/ 3	10.00 - 10.00	6.900 - 8.600	7.750	63000.0000			
* Petroleum Hydrocarbons, TPH	MG/KG	10/ 23	62.00 - 90.00	75.000 - 730.000	214.800	10.0000	10		
Toluene	UG/KG	8/ 23	3.60 - 10.00	3.000 - 5.000	3.700	1600000.0000			
Vanadium	MG/KG	22/ 23	3.10 - 3.10	4.450 - 30.400	11.913	55.0000		77.380	
Zinc	MG/KG	14/ 23	8.00 - 29.90	11.250 - 269.000	64.425	2300.0000		214.300	1

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- h Endrin used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.2.5
SWMU 13
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/L	1/ 9	11.00 - 11.00	2.400 - 2.400	2.400	220.0000			
Aluminum	UG/L	1/ 9	14.00 - 66.80	755.000 - 755.000	755.000	3700.0000			
Arsenic	UG/L	1/ 9	3.80 - 7.70	12.100 - 12.100	12.100	0.0380	1	27.990	
Butylbenzylphthalate	UG/L	1/ 9	11.00 - 11.00	2.300 - 2.300	2.300	730.0000			
Calcium	UG/L	9/ 9		79300.000 - 148000.000	103344.444				
4,4'-DDT	UG/L	1/ 9	0.10 - 0.10	0.100 - 0.100	0.100	0.2000			
Iron	UG/L	8/ 9	13.90 - 13.90	188.000 - 4120.000	1702.875				
Magnesium	UG/L	9/ 9		3680.000 - 78700.000	23457.777				
Manganese	UG/L	9/ 9		12.000 - 925.000	282.844	18.0000	8	3391.000	
Phenanthrene	UG/L	1/ 9	11.00 - 11.00	3.600 - 3.600	3.600	150.0000k			
Potassium	UG/L	9/ 9		2940.000 - 59800.000	24348.888				
Sodium	UG/L	9/ 9		5140.000 - 318000.000	94415.555				
Vanadium	UG/L	1/ 9	3.10 - 5.30	13.600 - 13.600	13.600	26.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- k Fluoranthene used as surrogate

Table 6.2.2.6
SWMU 13
Shallow Groundwater, Sampling Round 02

	Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
	Acenaphthene	UG/L	1/ 9	11.00 -	46.00	2.500 -	2.500	2.500	220.0000			
	Aluminum	UG/L	2/ 9	15.40 -	15.40	22.100 -	166.000	94.050	3700.0000			
	Arsenic	UG/L	3/ 9	2.60 -	2.60	4.100 -	7.400	5.466	0.0380	3	27.990	
	Barium	UG/L	8/ 9	0.80 -	0.80	1.100 -	20.400	7.425	260.0000		323.000	
*	Beryllium	UG/L	1/ 9	0.20 -	0.20	0.210 -	0.210	0.210	0.0160	1		
	Calcium	UG/L	9/ 9			41200.000 -	136000.000	104677.777				
	Cobalt	UG/L	1/ 9	2.40 -	2.40	3.600 -	3.600	3.600	220.0000			
	Fluorene	UG/L	1/ 9	11.00 -	46.00	3.800 -	3.800	3.800	150.0000			
	Iron	UG/L	9/ 9			95.000 -	5780.000	2289.333				
	Magnesium	UG/L	9/ 9			5590.000 -	66700.000	23890.000				
	Manganese	UG/L	9/ 9			51.300 -	862.000	313.944	18.0000	9	3391.000	
	2-Methylnaphthalene	UG/L	1/ 9	11.00 -	46.00	3.000 -	3.000	3.000	150.0000i			
	Potassium	UG/L	9/ 9			7570.000 -	63500.000	24324.444				
	Selenium	UG/L	3/ 9	3.50 -	3.50	3.300 -	5.400	4.066	18.0000		3.150	3
	Sodium	UG/L	9/ 9			14300.000 -	370000.000	113922.222				
	Zinc	UG/L	2/ 9	6.30 -	15.70	10.600 -	20.400	15.500	1100.0000			

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

i Naphthalene used as surrogate

Table 6.2.2.7
Exposure Pathways Summary — SWMU 13
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Site User (Firefighter Trainees and Instructors)	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were reported in surface soils, and portions of the site area is paved/covered by buildings.
	Air, Inhalation of chemicals entrained in fugitive dust	No	A significant portion of the site area is paved/covered by buildings. The remaining soils are covered by vegetation which would be expected to minimize any fugitive dust emissions onsite.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 13.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 13.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were reported in surface soils, and a significant portion of the site area is paved/covered by buildings.
	Air, Inhalation of chemicals entrained in fugitive dust	No	A significant portion of the site area is paved/covered by buildings. The remaining soils are covered by vegetation which would be expected to minimize any fugitive dust emissions onsite.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater COPCs were identified subsequent to risk-based and background screening of maximum shallow groundwater concentrations.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Shallow groundwater COPCs were identified subsequent to risk-based and background screening of maximum shallow groundwater concentrations.

Table 6.2.2.7
Exposure Pathways Summary — SWMU 13
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the future site worker and hypothetical residential scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the future site worker and hypothetical residential scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.2.8
Statistical Analysis of COPCs
Surface Soils at SWMU 13
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed SD	Mean	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Benzo(a)pyrene Equivalents	23	0.22	4.07	1.777	0.065	0.122	0.065	UCL used	1	0.065
Heptachlor	23	1.24	0.99	2.872	0.012	0.39	0.012	UCL used	NA	0.012

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.2.9
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.065	8.93E-08	8.34E-07	1.02E-07	3.19E-08	1.14E-08
Heptachlor	NA	0.012	1.70E-08	1.59E-07	1.94E-08	6.07E-09	2.17E-09

NOTES:

lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 6.2.2.10
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.065	0.01	3.66E-08	1.21E-07	2.29E-08	2.62E-08	9.34E-09
Heptachlor	NA	0.012	0.01	6.97E-09	2.30E-08	4.36E-09	4.98E-09	1.78E-09

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.2.11
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Beryllium	0.00021	5.75E-06	1.34E-05	3.16E-06	2.14E-06	1.05E-06

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

le 6.2.2.12 - SWMU 13
icological Database Information
Chemicals of Potential Concern
/BASE Charleston, Zone H

	Non-Carcinogenic Toxicity Data									
mical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation
yllium	0.005	a	L	microscopic organ changes	100	ND				ND
zo(a)pyrene Equivalents	ND				ND	ND				ND
tachlor	0.0005	a	L	liver weight increase	300	ND				ND
ethylnaphthalene	0.04	f								

NOTES:

a Integrated Risk Information System (IRIS)
e EPA Environmental Criteria and Assessment Office - Cincinnati (provisional)
f Withdrawn from IRIS or HEAST
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

able 6.2.2.12 - SWMU 13
oxicological Database Information
r Chemicals of Potential Concern
AVBASE Charleston, Zone H

	Carcinogenic Toxicity Data					
hemical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
eryllium	4.3	a	8.4	a	B2	osteosarcoma
enzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
eptachlor	4.5	a	ND		B2	liver tumors
Methylnaphthalene						

Table 6.2.2.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	7.5E-07	ND	8.3E-08
Heptachlor	0.0005	4.5	0.000034	0.00032	8.7E-08	0.000012	9.8E-09
SUM Hazard Index/ILCR			0.000034	0.00032	8E-07	0.000012	9E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.2.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	3.3E-07	ND	1.4E-07
Heptachlor	0.5	0.00025	9	0.000028	0.000092	3.9E-08	0.000020	1.6E-08
SUM Hazard Index/ILCR				0.000028	0.000092	4E-07	0.000020	2E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.2.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Beryllium	0.005	4.3	0.0012	0.0027	1.4E-05	0.00043	4.5E-06
SUM Hazard Index/ILCR			0.001	0.003	1E-05	0.0004	5E-06

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk

Table 6.2.2.16
Central Tendency Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Beryllium	0.00021	2.02E-06	6.73E-06	4.04E-07	1.35E-06	1.33E-07

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.2.17
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
SWMU 13
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Beryllium	0.005	4.3	0.00040	0.0013	1.7E-06	0.00027	5.7E-07
SUM Hazard Index/ILCR			0.0004	0.001	2E-06	0.0003	6E-07

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk

Table 6.2.2.18
Summary of Risk and Hazard for SWMU 13
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.00003	0.00032	8E-07	0.00001	9E-08
	Dermal Contact	0.00003	0.00009	4E-07	0.00002	2E-07
Shallow Groundwater	Ingestion	0.001	0.003	1E-05	0.0004	5E-06
Sum of All Pathways		0.001	0.003	1E-05	0.0005	5E-06

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

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val Base Charleston, SWMU 13 Shallow Groundwater
ıarleston, South Carolina

ıemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	10 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
ɛryllium	4.3	0.005	0.00021	0.0078	0.078	0.78	0.000015	0.00015	0.0015	0.004	ND
Methylnaphthalene	NA	NA	0.003	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

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/orker-Based Remedial Goal Options
aval Base Charleston, SWMU 13 Shallow Groundwater
harleston, South Carolina

				Hazard-Based Remedial Goal Options			Risk-Based Remedial Goal Options				
hemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	0.1 mg/l	1.0 mg/l	10 mg/l	1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
eryllium	4.3	0.005	0.00021	0.049	0.49	4.91	0.000046	0.00046	0.0046	0.004	ND
-Methylnaphthalene	NA	NA	0.003	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

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6.2.3 Baseline Risk Assessment for Combined SWMU 14 (Including SWMU 15 and AOCs 669, 670 and 684)

6.2.3.1 Site Background and Investigative Approach

This site's soil and groundwater were assessed for potential effects of past site activities. This SWMU includes a former chemical disposal area, the site of a former propane-fired incinerator, and three weapons firing ranges (one still active). No specific sampling was performed at AOC 669.

Soil

SWMU 14

Samples were collected from surface soil (0 to 1 foot deep) at 13 locations. Table 6.2.3.1 lists surface soil sample locations and analytical methods used. The number of soil samples differs for various analytes because specific groups of analytes were targeted at certain sample locations, as shown in Table 6.2.3.1.

SWMU 15

Samples were collected from surface soil at 10 locations. Table 6.2.3.2 lists surface soil sample locations and analytical methods used. The number of soil samples differs for various analytes because specific groups of analytes were targeted at certain sample locations, as shown in Table 6.2.3.2.

AOC 670

Samples were collected from surface soil at 36 locations. Table 6.2.3.3 lists surface soil sample locations and analytical methods used. The number of soil samples differs for various analytes because specific groups of analytes were targeted at certain sample locations, as shown in Table 6.2.3.3.

Sediment was sampled at two locations at AOC 670. Sediments at AOC 670 are infrequently covered with water and, as a result, they are addressed within the soil pathway risk assessment.

AOC 684

Samples were collected from surface soil at 45 locations. Table 6.2.3.4 lists surface soil sample locations and analytical methods used. The number of soil samples differs for various analytes because specific groups of analytes were targeted at certain sample locations, as shown in Table 6.2.3.4.

Sediment was also sampled at two locations. Sediments at AOC 684 are infrequently covered with water and, as a result, they are addressed within the soil pathway risk assessment.

Groundwater

Sitewide

Groundwater samples were collected from five shallow and five deep monitoring wells for both first- and second-quarter monitoring rounds and analyzed for parameters similar to those analyzed for soil samples. Shallow groundwater sample locations and analytical methods for the first and second quarters are listed in Tables 6.2.3.5 and 6.2.3.6, respectively. Deep groundwater sample locations and analytical methods for the first and second quarters are listed in Tables 6.2.3.7 and 6.2.3.8.

6.2.3.2 COPC Identification

Soil

SWMU 14

The following COPCs were identified at SWMU 14 for the surface soil exposure pathways: aluminum, BEQs, chromium, and lead. Results of the Wilcoxon rank sum test indicate that the data for five inorganics — arsenic, beryllium, manganese, thallium, and vanadium — are significantly higher than background in surface soil at SWMU 14, and should be included as

COPCs in this HHRA. TPH was identified in one of nine samples at a concentration of 150 mg/kg, which exceeds the soil AL of 100 mg/kg.

SWMU 15

The following COPCs were identified at SWMU 15 for the surface soil exposure pathways: arsenic and BEQs. Results of the Wilcoxon rank sum test indicate that the inorganic manganese is significantly higher than background in surface soil at SWMU 15 and should be included as a COPC in this HHRA.

AOC 670

The following COPCs were identified at AOC 670 for the surface soil exposure pathways: antimony, arsenic, BEQs, lead, and thallium. Results of the Wilcoxon rank sum test indicate that data for six inorganics — aluminum, beryllium, chromium, manganese, nickel, and vanadium — are significantly higher than background in surface soil at AOC 670, and should be included as COPCs in this HHRA. Indeterminate lubricating oil (a petroleum hydrocarbon) was identified in one of nine samples analyzed at a concentration of 150,000 μg/kg, which exceeds the NAVBASE AL of 100 mg/kg.

Based on the screening comparisons for sediment discussed in Section 4 of this report, the soil COPCs mentioned above are consistent with those identified in AOC 670 sediment. Sediment COPC concentrations were also comparable. As a result, sediment exposures were not evaluated separately and soil pathways results should be considered applicable to site sediment.

AOC 684

The following COPCs were identified at AOC 684 for the surface soil exposure pathways: antimony, Aroclors-1254 and 1260, arsenic, BEQs, beryllium, 7,12-dimethylbenz(a)anthracene, and thallium. Results of the Wilcoxon rank sum test indicate that the inorganic vanadium is significantly higher than background in surface soil at AOC 684 and should be included as a

COPC in this HHRA. TPH was identified in nine of 24 samples analyzed at concentrations ranging from 63 to 7,700 mg/kg, compared to the soil AL of 100 mg/kg.

The COPCs mentioned above were consistent with those identified in AOC 684 sediment. Sediment COPCs concentrations were also comparable. As a result, sediment exposures were not evaluated separately, and soil pathways results should be considered applicable to site sediment. TPH was also identified in both sediment samples analyzed at concentrations ranging from 780 to 2,100 mg/kg.

Groundwater

Sitewide

As shown in Table 6.2.3.13, the COPCs identified in shallow groundwater for this combined site based on first-quarter results are TEQs and BEHP. Second-quarter results, presented in Table 6.2.3.14, identified aluminum, chromium, lead, and vanadium as COPCs. Results of the Wilcoxon rank sum test indicate that the data for manganese are significantly higher than background in shallow groundwater, supporting its inclusion as a COPC in this HHRA.

As shown in Table 6.2.3.15, the COPCs identified in deep groundwater for this combined site based on first-quarter results are barium, cadmium, carbon disulfide, chloroform, TEQs, BEHP, heptachlor epoxide, and thallium. Second-quarter results, presented in Table 6.2.3.16, identified cadmium as the sole COPC. No additional COPCs were identified for deep groundwater as a result of the Wilcoxon rank sum test.

6.2.3.3 Exposure Assessment

Exposure Setting

The exposure setting at combined SWMU 14 is an area near the southern end of NAVBASE, where several sites are either adjacent to or occupy common tracts of land. Combined SWMU 14 includes a former chemical disposal area where miscellaneous chemicals and "warfare decontaminating agents" were buried. This area also includes the former site of a propane-fired incinerator (SWMU 15), which was reportedly used from 1983 to 1992 to destroy classified documents. Only the concrete slab and propane tank saddles remain.

Combined SWMU 14 also includes three weapons firing ranges. The current indoor pistol range (AOC 669) was constructed in 1981 in Building 1888. Lead bullets are trapped by a steel bullet trap which is emptied weekly, into sealed 55-gallon drums, staged on a concrete pad adjacent to the building, and removed from the AOC within 72 hours. Formerly, lead waste was discarded into the sewer system via floor drains that have since been sealed.

The former outdoor pistol range (AOC 684) and outdoor trap/skeet range (AOC 670) were operated until 1981 and the late 1970s, respectively. Lead bullets/shot and broken clay targets were not recovered.

Combined SWMU 14 is within an area of Zone H scheduled to become part of a marine industrial park and intermodal railyard, according to current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations include current and future site workers. Additional potentially exposed populations are the instructors and trainees who use the indoor pistol range in Building 1888 and hypothetical future site residents. Because many traditional activities at NAVBASE have ceased or are expected to cease in the near future, current site workers were not specifically addressed in the formal assessment. Due to the lack of information regarding the specific functions that will be performed by future site workers, a standard default scenario was developed for these individuals. A similar approach was applied for future site residents.

Exposure Pathways

Exposure pathways for future site workers and site residents were based on an evaluation of the impacted media identified at SWMU 14. Relative to the soil matrix, incidental ingestion and dermal contact were considered as viable exposure pathways. Two distinct water-bearing zones (shallow and deep) exist at SWMU 14. Ingestion of COPCs identified in shallow groundwater were assessed in this HHRA. No volatile COPCs were identified in the shallow aquifer. For deep groundwater, ingestion and inhalation exposure pathways were evaluated. Sediment from shallow drainage swales was sampled at AOCs 670 and 684. Because these areas seldom retain standing water, exposure conditions/pathways would not be expected to differ from those of surface soil. As a result, no specific exposure pathways scenarios were developed. The CDIs computed for surface soil and the respective AOC should be considered to be representative of related sediment exposure. Uniform exposure was assumed for all sample locations. Table 6.2.15.17 presents the exposure pathway selection process and justifies each pathway evaluated.

Exposure Point Concentrations

UCLs were calculated for datasets with at least 10 samples. Surface soil EPCs for SWMU 14 and AOCs 670 and 684 are based on UCLs. Calculations are shown in Tables 6.2.3.18, 6.2.3.19, and 6.2.3.20. Fewer than 10 samples delineate the extent of CPSS in SWMU 15 surface soil, and the maximum reported concentrations were used as EPCs at this site. EPCs for shallow and deep groundwater are based on the maximum reported concentrations as only five monitoring wells are installed in each aquifer.

Quantification of Exposure

Soil

SWMU 14

CDIs for ingestion and dermal contact with SWMU 14 surface soil are shown in Tables 6.2.3.21 and 6.2.3.22, respectively.

SWMU 15

CDIs for ingestion and dermal contact with SWMU 15 surface soil are shown in Tables 6.2.3.23 and 6.2.3.24, respectively.

AOC 670

CDIs for ingestion and dermal contact with AOC 670 surface soil are shown in Tables 6.2.3.25 and 6.2.3.26, respectively.

AOC 684

CDIs for ingestion and dermal contact with AOC 684 surface soil are shown in Tables 6.2.3.27 and 6.2.3.28, respectively.

Groundwater

Sitewide

CDIs for shallow groundwater ingestion are presented in Table 6.2.3.29. CDIs for deep groundwater ingestion/inhalation are presented in Table 6.2.3.30.

6.2.3.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.5 of this report. Table 6.2.3.31 summarizes toxicological risk information for the COPCs identified at combined SWMU 14. The following are toxicological profiles for each COPC identified at combined SWMU 14.

Heptachlor is an insecticide which was used to control flies, mosquitoes, and field insects. USEPA determined this compound to be a class B2 carcinogen, and determined the SF_o to be 4.5 $(mg/kg\text{-}day)^{-1}$. As listed in IRIS (search date 6/29/95), the classification is based on inadequate human data, but sufficient evidence exist from studies in which benign and malignant liver tumors were induced in three strains of mice of both sexes (Dreisbach et al., 1987). The primary target organs for this pesticide are the liver and kidneys, and USEPA determined the RfD_o to be 0.0005 mg/kg-day. As listed in IRIS, the critical effect of this chemical is liver weight increases in males. The uncertainty factor was 300 and the modifying factor was 1.

Heptachlor epoxide is the more toxic form of the insecticide heptachlor. Benign and malignant liver tumors were induced in three strains of mice of both sexes. Heptachlor epoxide has been linked to liver carcinoma (Dreisbach et al., 1987). USEPA determined this compound to be a class B2 carcinogen, and determined the SF_o to be 9.1 $(mg/kg\text{-}day)^{-1}$. The primary target organs for this pesticide are the liver and kidneys, and USEPA determined the RfD_o to be 1.3E 5 mg/kg-day.

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used as a rodenticide and ant killer, which is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's RfD_o for thallium is 0.00008 mg/kg-day (Klaassen et al., 1986; Dreisbach et al., 1987).

Aluminum is one of the most abundant metals in the earth's crust (7% aluminum), and it is ubiquitous in air and water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuro-muscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen et al., 1986; Dreisbach et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based secondary MCL (SMCL) for drinking water is 50 to 200 μg/L (USEPA Office of Water).

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al., 1986). USEPA set 0.3 μg/kg/day as the RfD for arsenic based on an NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has caused cancer in humans. Inhalating these materials can lead to increased lung cancer risk, and ingesting them is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 (mg/kg-day)$^{-1}$ SF for arsenic. As listed in IRIS (search date 9/1/95), the classification is based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.038 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has caused kidney damage (including kidney stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system (Klaassen et al., 1986). An oral RfD of 0.001 (mg/kg-day) has been determined by USEPA, based on human studies (food) involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for water has been determined by USEPA to be 0.0005 mg/kg-day. For inhalation exposure, cadmium has been classified by USEPA as a group B1, or probable human carcinogen, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. As listed in IRIS (search date 6/28/95), classification is based on limited evidence from occupational epidemiologic studies that is consistent across investigations and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven rat and mice studies where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route. As listed in IRIS, the critical effect of this chemical in water is significant proteinuria. The uncertainty factor was determined to be 10 and the modifying factor was determined to be 1.

Chromium exists in two stable, natural forms: trivalent (CrIII), and hexavalent (CrVI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (Gradient, 1991). Oral RfD values for both forms of chromium are 1.0 and 5E-3 (mg/kg-day). For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and a SF_0 of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS (search date 6/28/95), no critical effects were observed for chromium (III). The uncertainty factor was determined to be 100 and the modifying factor was determined to be 10.

As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor was 500 and the modifying factor was 1.

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaassen et al., 1986; Dreisbach et al., 1987). Because of the different uptake rates in water and food, USEPA set two oral RfDs — one for water (0.005) and one for food 0.14 mg/kg-day. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS (search date 6/29/95), the classification is based on existing studies that are inadequate to assess manganese's carcinogenicity. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS (the critical effect of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the modifying factor was 1. The critical effects in food in the oral summary are CNS effects. The uncertainty factor was 1 and the modifying factor was 1. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. The uncertainty factor was 1000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

PCB Aroclors are a group of chlorinated hydrocarbons (such as ***Aroclors-1248, 1254, and 1260***) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme concentrations, rashes and chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen et. al., 1986; Dreisbach et al., 1987). USEPA classified PCB Aroclors as group B2 carcinogens, primarily based on animal data. As listed in IRIS (search date 6/29/95), the classification is based on hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate, and suggestive evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. USEPA set 7.7 (mg/kg-day)$^{-1}$ as the SF_o for PCB Aroclors, and the RfD was set to 0.00007 mg/kg-day.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an SF 7.3_o (mg/kg-day)$^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the BAP B2 classification is based on insufficient human data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified (see Additional Comments for Oral Exposure). This section provides information on three aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classifications are based on no human data but sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the benzo(a)anthracene B2 classification is based on no human data but sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS (search date 6/28/95) the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Although not specifically referenced in the IRIS, 7,12-dimethylbenz(a)anthracene was considered as a carcinogen in the formal risk assessment. Due to structural similarities, the TEF for benzo(a)anthracene (TEF = 0.1) was applied for this compound.

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene***. USEPA determined RfDs for only two of these compounds: pyrene's RfD_o of 0.03 mg/kg-day is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was 0.06 mg/kg-day.

Dioxins are chlorinated hydrocarbons that accumulate in fat tissue. Exposure to dioxins, known to be potent mutagens and teratogens, causes burning pain in the tongue, abdomen, and pharynx, chloracne, loss of body weight, degenerative changes to the liver and thymus, and psychiatric disturbances. Chloracne is the primary sign of human exposure (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified dioxins as group B2 carcinogens and determined the SF_o to be 150,000 $(mg/kg\text{-}day)^{-1}$ for 2,3,7,8-TCDD. Equivalent concentrations of other dioxin congeners were calculated based on their corresponding toxic equivalents, as recommended by USEPA.

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an AL for soil protective of child residents has been proposed by USEPA Region IV: 400 mg/kg. OSWER has recommended a 1,000 mg/kg cleanup standard for industrial properties. USEPA's Office of Water has established a treatment technique action level of 15 μg/L. As listed in IRIS (search date 10/17/95), classification is based on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen, et al., 1986). The USEPA has developed the Lead Model to assist in determining the probability that children (0 to 7 years of age) would suffer adverse effects as a result of exposure to environmental media impacted by lead. The model was applied to assess the threat to a child receptor posed by elevated surface soil lead concentrations reported at AOC 670. The Lead Model applications are discussed in Section 6.2.3.5.

Vanadium is not readily absorbed through the skin or oral ingestion and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaassen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust. Typical vitamin supplements contain approximately 0.010 mg in a daily dose. The RfD_o set by USEPA is 0.007 mg/kg-day.

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract. Another target is the blood, where antimony concentrates. Due to frequent industrial use, the primary exposure route for antimony to the general population is food. Antimony is also a common air pollutant from industrial emissions (Klaassen et al., 1986). USEPA has not classified antimony as a carcinogen, and the RfD_o is 0.0004 mg/kg-day. As listed in IRIS (search date 6/28/95), the critical effect of this chemical is longevity, changes in blood glucose levels, and cholesterol. The uncertainty factor was 1,000 and the modifying factor was 1.

Barium is used in various alloys, paints, soap, and manufacturing processes. Barium sulfate, which is used to aid X-ray diagnosis, is relatively abundant in nature and found in plant and animal tissue (Dreisbach et al., 1987; Klaassen et al., 1986). Brazil nuts contain 3 to 4 mg per gram nuts. The fatal absorbed dose of barium is approximately 1,000 mg (for humans). Assuming an absorption efficiency of 5% for barium, 20,000 mg ingested barium could be fatal (approximately 333 Brazil nuts, assuming 15 g/nut). Major toxic effects of this element are muscle stimulation, CNS effects, and effects on the heart. USEPA determined the RfD_o and RfD_i to be 0.07 and 1.43E-4 mg/kg-day. As listed in IRIS (search date 6/29/95), the critical effect of this chemical is increased blood pressure. The uncertainty factor was 3 and the modifying factor was 1.

Beryllium exposure via the inhalation route can cause inflame the lungs, a condition known as Acute Beryllium Disease, as a result of short-term exposure to high concentrations. Removal from exposure results reverses the symptoms. Chronic exposure to much lower concentrations of beryllium or beryllium oxide by inhalation has been reported to cause chronic beryllium disease, with symptoms including shortness of breath, scarring of the lungs, and berylliosis, which is noncancerous growths in the lungs of humans. Both forms of beryllium disease can be fatal, depending on the severity of the exposure. Additionally, a skin allergy may develop when soluble beryllium compounds come into contact with the skin of sensitized individuals

(Gradient, 1991). An oral RfD of 0.0054 mg/kg-day has been set for beryllium based on a chronic oral bioassay (rats were the study species) which determined no adverse effect occurs at 0.54 mg/kg-day. Beryllium has been classified by USEPA as a group B2 carcinogen based on animal studies. Human epidemiology studies of beryllium are considered to be inadequate. As listed in IRIS (search date 6/28/95), the classification is based on beryllium inducing lung cancer via inhalation in rats and monkeys and osteosarcomas in rabbits via intravenous or intramedullary injection. An inhalation slope factor of 8.4 $(mg/kg\text{-}day)^{-1}$ and an oral SF of 4.3 $(mg/kg\text{-}day)^{-1}$ have been set by USEPA. As listed in IRIS, this chemical has no critical adverse effect. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfD in drinking water is 0.005 mg/kg-day.

Carbon disulfide is a VOC that affects the nervous system. At toxic concentrations, nervous system effects in humans include psychosis, tremor, and weakness in the lower extremities. This compound interferes with the conduction of nerve signals to produce these effects. Carbon disulfide has been associated with reproductive dysfunction in men and women. In addition, at doses well within what was thought to be safe for industry in Japan, some effects on the eye have been produced, and similar effects were observed in Finland (Klaassen et al., 1986). USEPA set the RfD_o and RfD_i to 0.1 and 0.00286 mg/kg-day, respectively. As listed in IRIS (search date 6/28/95), the critical effect of this chemical is fetal toxicity/malformations. The uncertainty factor was 100 and the modifying factor was 1.

Chloroform is a halogenated volatile organic. This compound targets the liver, kidney and central nervous system (Dreisbach et al., 1987). In addition, chloroform is classified as a B2 carcinogen by USEPA. As listed in IRIS (search date 11/22/95), the classification is based on inadequate human data but sufficient evidence of carcinogenicity in animals, namely an increased incidence of tumors after oral administration of chloroform in rats and intraperitoneal administration in mice. Chloroform is genotoxic in several assay systems. Also, chloroform is structurally related to other trihalomethanes (e.g., bromodichloromethane, bromoform, dibromochloromethane) which have been verified as either probable or possible carcinogens. The SF_o and SF_i are 0.0061 and 0.0805 $(mg/kg\text{-}day)^{-1}$, respectively. The RfD_o is 0.01 mg/kg-day. As listed in IRIS (search date 11/22/95), the critical effect of this chemical is liver lesions. The uncertainty factor was 1,000 and the modifying factor was 1.

BEHP, is a plasticizer used in virtually every major product category. Phthalate esters are ubiquitously distributed in the environment. Although the toxicity of this compound is relatively low, it is a carcinogen. Reproductive effects are also possible (indicated in animal studies) due to chronic exposure to BEHP (Klaassen et al., 1986). As listed in IRIS (search date 10/17/95), the classification is based on orally administered BEHP producing significant dose-related increase in liver tumor responses in rats and mice of both sexes. This compound is classified as a B2 carcinogen and USEPA set the RfD_o and SF_o to 0.02 mg/kg-day and 0.014 $(mg/kg\text{-}day)^{1}$, respectively. As listed in IRIS, the critical effect of this chemical is increased relative liver weight. The uncertainty factor was 1,000 and the modifying factor was 1.

Nickel is also an essential nutrient with a 5 μg dose typical of supplemental vitamins. USEPA set the RfD_o to 0.02 mg/kg-day. Chronic exposure of rats to nickel decreased body and organ weights. For a chronically exposed individual, nickel salts would affect the gastrointestinal system, and would also target the liver and kidney. This element has been shown to be a sensitizer, an element that can produce allergic reactions. Sensitization of skin to nickel dust has been shown to occur in industry (Dreisbach et al., 1987). As listed in IRIS (search date 6/28/95), the critical effect of this chemical is decreased body and organ weights. The uncertainty factor was 300 and the modifying factor was 1.

6.2.3.5 Risk Characterization

Surface Soil Pathways

Incidental and dermal exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Soil pathways were evaluated for each SWMU or AOC as noted in the corresponding tables and discussions.

SWMU 14

Tables 6.2.3.32 and 6.2.3.33 list the computed carcinogenic risks and/or HQs associated with the incidental of and dermal contact with SWMU 14 surface soil.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) is 5E-5. The dermal pathway ILCR is 9E-6. Arsenic, BEQs, and beryllium were the primary contributors for the ingestion and dermal pathways.

The computed HI for the adult resident was 0.1 for the soil ingestion pathway. The computed HI for the child ingestion pathway was 1, with aluminum (HQ=0.4), arsenic (HQ=0.6), and vanadium (HQ=0.1) as the primary contributors. The dermal contact pathway HI were less than 0.1 for both the adult resident (HI=0.02) and the child resident (HI=0.08).

Surface soil COCs identified at SWMU 14 based on their contribution to risk/hazard are: aluminum, arsenic, BEQs, beryllium, and vanadium.

Hypothetical Site Workers

Site worker ILCRs are 6E-6 and 4E-6 for the ingestion and dermal contact pathways. Arsenic and BAP were the only contributors for both pathways. The HI for the ingestion and dermal hypothetical site worker were both projected to be less than 0.1.

COCs identified for this scenario based on their contribution to risk/hazard are: arsenic, beryllium (based on combined ingestion/dermal contact), and BEQs.

Lead Toxicity

At SWMU 14, three surface soil samples contained lead at concentrations exceeding the residential cleanup goal of 400 mg/kg. Figure 6.2.3.1 shows surface soil lead concentrations across combined SWMU 14. The mean lead concentration at SWMU 14 was calculated to be 385 mg/kg. Because the mean falls below the residential cleanup goal, chronic exposures are not expected to pose a significant health threat. In contrast to the 400 mg/kg cleanup goal based on child resident exposure, USEPA Region IV has calculated a soil cleanup/screening level for lead of 1,300 mg/kg based on adult exposures. The most likely receptors, considering the proposed industrial use of the SWMU 14 area, are adults rather than children. The maximum surface soil concentration for SWMU 14 (915 mg/kg) falls below the USEPA cleanup/screening level based on adult exposure.

SWMU 15

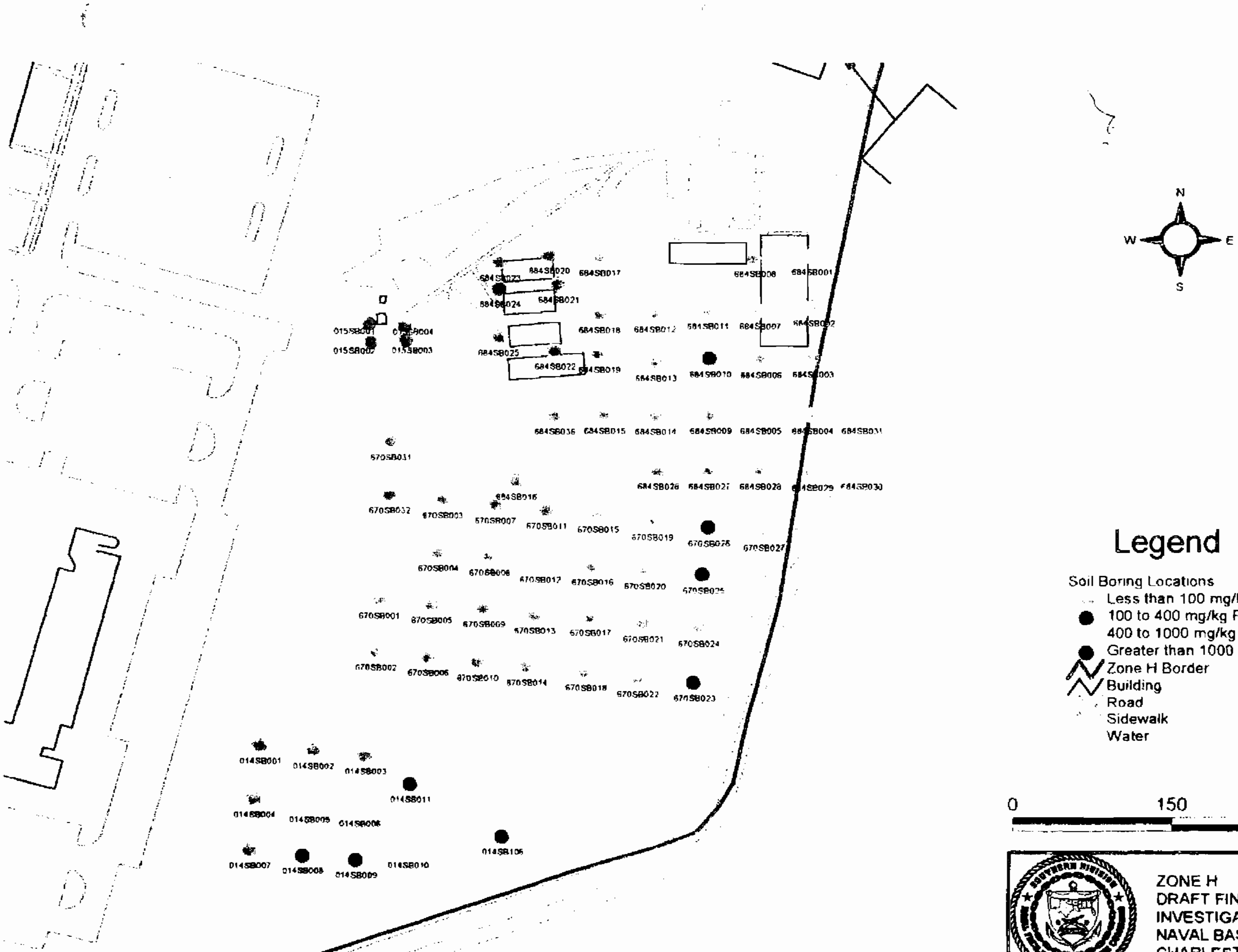
Tables 6.2.3.34 and 6.2.3.35 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with SWMU 15 surface soil.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) is 1E-4. The dermal pathway ILCR is 2E-5. Arsenic and BEQs were the primary contributors for both pathways.

The computed HI for the adult resident was 0.2 for the soil ingestion pathway. The computed HI for the child ingestion pathway was 2, with arsenic (HQ=2.3) as the primary contributor. The dermal contact pathway HIs were 0.05 for the adult resident and 0.2 for the child resident.

COCs identified for this scenario based on their contribution to risk/hazard are arsenic and BEQs.



Legend

Soil Boring Locations
- Less than 100 mg/kg Pb
- 100 to 400 mg/kg Pb
- 400 to 1000 mg/kg Pb
- Greater than 1000 mg/kg Pb
- Zone H Border
- Building
- Road
- Sidewalk
- Water

0 150 300 Feet

ZONE H
DRAFT FINAL RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 6.2.3.1
NAVBASE - CHARLESTON ZONE H
SWMU 14 SURFACE SOIL
LEAD CONCENTRATIONS

DWG DATE: 12/14/95 | DWG NAME: SWMU14.APR

Hypothetical Site Workers

Site worker ILCRs are 2E-5 and 1E-5 for the ingestion and dermal contact pathways. Arsenic and BEQs were the only contributors for both pathways. The HIs for the ingestion and dermal hypothetical site worker were 0.09 and 0.04.

COCs identified for this scenario based on their contribution to risk/hazard are arsenic and BEQs.

AOC 670

Tables 6.2.3.36 and 6.2.3.37 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with AOC 670 surface soil.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) is 6E-5. The dermal pathway ILCR is 1E-5. Arsenic and BEQs were the primary contributors for both pathways.

The computed HI for the adult resident was 0.2 for the soil ingestion pathway. The computed HI for the child ingestion pathway was 1, with antimony (HQ=0.3), arsenic (HQ=0.6), thallium (HQ=0.1), and aluminum (HQ=0.2) as the primary contributors. The dermal contact pathway HIs were less than or equal to 0.1 for both the adult resident (HI=0.03) and the child resident (HI=0.1).

COCs identified for this scenario based on their contribution to risk/hazard are aluminum, antimony, arsenic, BEQs, and thallium.

Hypothetical Site Workers

Site worker ILCRs are 6E-6 and 5E-6 for the ingestion and dermal contact pathways; respectively. Arsenic and BEQs were the only contributors for both pathways. The HIs for the ingestion and dermal hypothetical site worker were both projected to be less than 0.1.

COCs identified for this scenario based on their contribution to risk/hazard are arsenic and BEQs.

Lead Toxicity

Background

Currently, USEPA has not established an SF reference dose for lead. USEPA believes that the available studies in animals and humans do not provide sufficient quantitative information for their calculation. Although lead is currently classified as a B2 carcinogen, USEPA considers the noncarcinogenic neurotoxic effects in children to be the critical toxic effect with respect to establishing health-based environmental cleanup objectives. The neurotoxic effects of chronic low-level lead exposure in children may occur at blood levels as low as 10 μg/dL.

In the absence of lead health criteria, USEPA Region IV's Office of Health Assessment sanctions the use of the Lead Model to predict mean blood lead levels in children based on exposure to impacted environmental media. This model was used to assess the potential health effects of elevated lead levels reported in surface soil at AOC 670. The maximum lead concentration reported in surface soil was 20,900 mg/kg at location 670SB023. Figure 6.2.3.1 shows the distribution of lead concentrations at AOC 670 (and SWMUs 14 and 15 and AOC 684).

Lead Uptake/Biokinetics Model

Blood lead levels in the age group 0 to 7 years can be predicted using the Lead Model. Such estimates can assist in risk management decisions regarding cleanup of lead at hazardous waste sites. The effects of lead exposure are complex, and the assumptions used in the Lead Model are updated to reflect recent research findings. The results presented are hypothetical estimates because many of the model assumptions are subject to change.

In coordination with USEPA Region IV's Office of Health Assessment, a conservative exposure scenario was developed to assess the significance of surface soil lead concentrations at AOC 670. This scenario involves a child (age 5 to 6) who gains access to the most heavily contaminated area for one day and is maximally exposed. The scenario was based on the proposed future use of the SWMU 14 area, which includes AOC 670. Current base reuse plans indicate that the area will become a marine industrial park and intermodal railyard. The exposure frequency was based on the child accompanying a parent to work at a nearby building on a one-time basis and wandering into AOC 670.

Exposure to site soil was addressed as an additional exposure relative to typical exposures encountered at the child's place of residence. This additional exposure was presented as an alternate source within the constructs of the Lead Model. The only modification made to standard default assumptions in the lead model was raising the drinking water lead concentration to the treatment technique action level (TTAL) of 15 μg/L. This change was made to provide a conservative estimate of daily intake from sources unrelated to AOC 670.

The assumption was made that this child would ingest 0.1 grams of soil from the most heavily contaminated area. In the case of AOC 670, the lead hot spot was identified as boring location 670SB023 and the three closest sampling locations surrounding this point (locations 670SB022, 670SB021 and 670SB024). The total area encompassed by these locations is approximately one-half acre, and the mean surface soil lead concentration is 5,255 mg/kg. Within the Lead Model, an alternate source was entered to account for this exposure as previously discussed. The bioavailability of lead ingested from the alternate source (AOC 670 surface soil) was equal to that of soil lead ingested from the standard residential default source. Assuming a one-time exposure in the most heavily impacted area, the annual alternate source exposure was estimated to be 1.44 μg lead/day. Table 6.2.3.38 presents the lead model output for a child 5 to 6 years old under these exposure conditions.

Child exposure is presented as a reasonable worst-case scenario for exposure to lead concentrations in AOC 670 soil. The most likely receptors, considering the proposed industrial use of the AOC 670 area, are adults rather than children. USEPA Region IV has calculated a soil cleanup/screening level for lead of 1,300 mg/kg based on adult exposures. The mean surface soil concentration for AOC 670 (1,213 mg/kg) falls below the USEPA adult cleanup/screening level; although the levels within the identified hot spot exceed this value.

Figure 6.2.3.2 shows the probability percentage of blood lead levels for the hypothetical child receptor. Based on this model output, the geometric mean blood level is estimated to be 3.9 μg/dL, and the probability of blood lead levels in excess of 10 μg/dL is 2.11%. USEPA generally considers media concentrations that result in probability percentage estimates of 5% or less sufficiently protective of potential child receptors. As a result, surface soil lead concentrations at AOC 670 would not require specific action under the hypothetical exposure scenario.

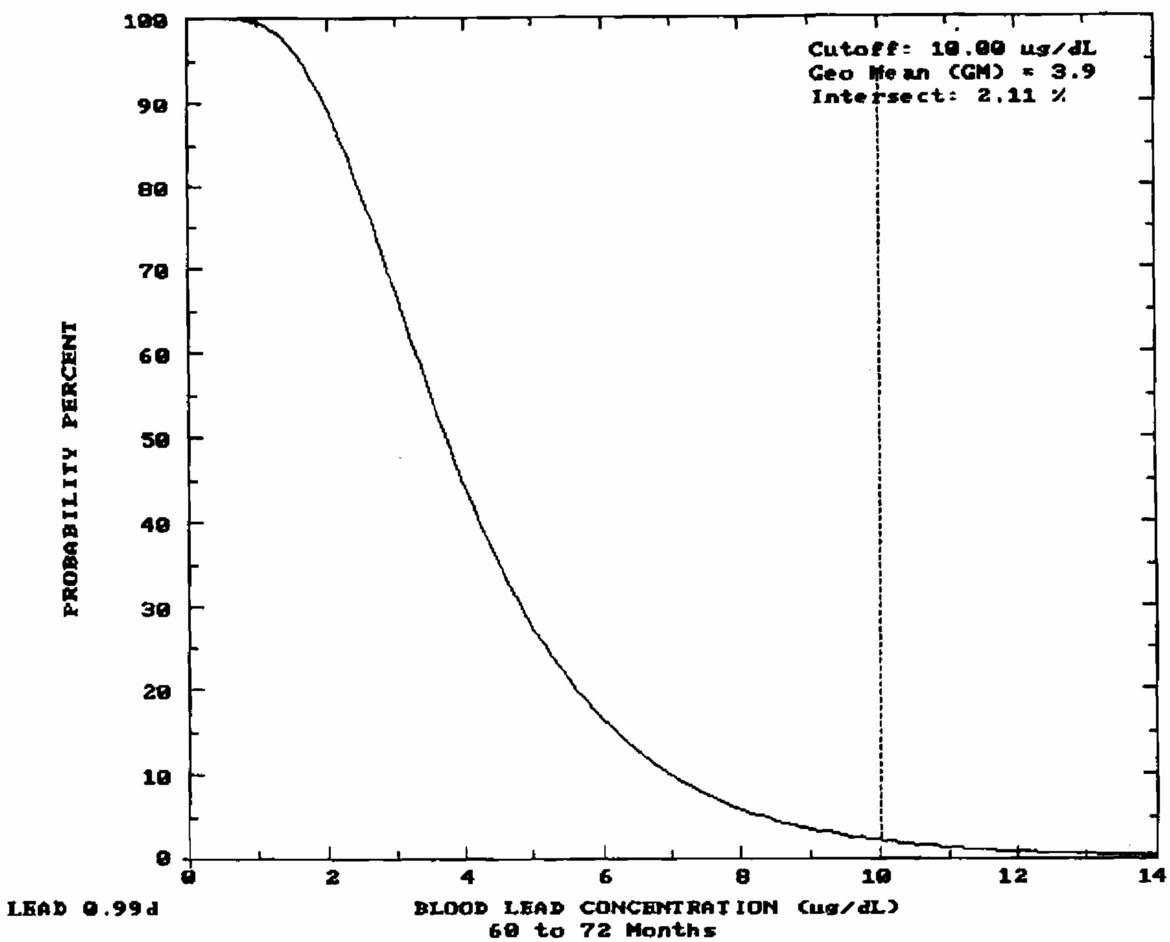
AOC 684

Tables 6.2.3.39 and 6.2.3.40 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with AOC 684 surface soil.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) is 8E-5. The dermal pathway ILCR is 3E-5. Arsenic, BEQs, and beryllium were the primary contributors for the ingestion pathway. Arsenic and BEQs were the primary contributors for the dermal pathway.

Figure 6.2.3.2
AOC 670 Lead Uptake/Biokinetic Model Output
Child Blood Lead Level Probability Percentage



Note: The probability percentage plot was provided as output from the USEPA Lead Uptake/Biokinetic Model (Version 0.99d) performed for AOC 670. The exposure assumptions used within the Lead Model are described in accompanying text.

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The computed HI for the adult resident was 0.09 for the soil ingestion pathway. The computed HI for the child ingestion pathway was 1, with arsenic (HQ=0.4), antimony (HQ=0.2), and thallium (HQ=0.1) as the primary contributors. The dermal contact pathway HIs were less than 0.1 for both the adult resident (HI=0.02) and the child resident (HI=0.07).

COCs identified for this scenario based on their contribution to risk/hazard are: antimony, arsenic, BEQs (including 7,12-dimethylbenz[a]anthracene), beryllium, thallium, and Aroclors-1254 and 1260 (based on combined ingestion/dermal contact pathways).

Hypothetical Site Workers

Site worker ILCRs are 9E-6 and 1E-5 for the ingestion and dermal contact pathways. Arsenic and BAP were the only contributors for both pathways. The HI for the ingestion and dermal hypothetical site worker were both projected to be less than 0.1.

COCs identified for this scenario based on their contribution to risk/hazard are arsenic and BEQs.

Groundwater Pathways

Groundwater at combined SWMU 14 is not currently a potable or process water source. Exposure to groundwater onsite was evaluated sitewide under both residential and industrial scenarios. For these scenarios, the ingestion and inhalation (while showering) exposure pathways were evaluated assuming the site will be used for residential purposes and that an unfiltered well, drawing from the corresponding water-bearing zone, will be the domestic water source. The ingestion and inhalation pathways were separately evaluated for shallow and deep groundwater as well as first- and second-quarter groundwater data. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately to address child and adult exposure.

Shallow Groundwater

Table 6.2.3.41 presents the risk and hazard for the ingestion exposure pathway for shallow groundwater.

Hypothetical Site Residents

The shallow groundwater ingestion ILCR for hypothetical site residents is 3E-5. TEQs, and BEHP were the primary contributors. The hazard indices for the ingestion pathway for the adult and child resident were 0.7 and 1.6. Aluminum and vanadium were the primary contributors. No volatile COPCs were identified in the shallow aquifer; consequently, the inhalation pathway was not evaluated.

COCs identified for this scenario based on their contribution to risk/hazard are aluminum, TEQs, BEHP, and vanadium.

Hypothetical Site Workers

The shallow groundwater risk posed to future site workers is 7E-6 ILCR for the ingestion exposure pathway. TEQs were the primary contributor. The HI for the ingestion exposure pathway was calculated to be 0.3.

COCs identified for this scenario based on their contribution to risk/hazard are TEQs.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for combined SWMU 14 or other areas of Zone H. In the absence of a completed exposure pathway, reported shallow groundwater contamination poses no threat to human health.

Deep Groundwater

Deep groundwater risk and hazard for the ingestion exposure pathway are listed in Table 6.2.3.42. Deep groundwater risk and hazard for the inhalation exposure pathway are listed in Table 6.2.3.43.

Hypothetical Site Residents

The deep groundwater ingestion ILCR for hypothetical site residents is 5E-4. Heptachlor epoxide, detected in one of five deep monitoring well samples in first-quarter samples only, accounts for more than 95% of the ingestion pathway ILCR. The inhalation pathway ILCR was projected to 2E-6 with chloroform contributing 100%.

For the deep groundwater ingestion pathway, the HIs were computed to be 7 for the resident adult and 17 for the resident child. The primary contributors are cadmium (HQ=0.2 adult, 0.4 child), heptachlor epoxide (HQ=6.8 adult, 15.9 child), and thallium (HQ=0.4 adult, 1 child). The inhalation pathway HIs are less than or equal to 0.1 for both residential receptors.

COCs identified for this scenario based on their contribution to risk/hazard are cadmium, chloroform, TEQs, BEHP, heptachlor epoxide, and thallium.

Hypothetical Site Workers

The deep groundwater ingestion ILCR for future site workers is 1E-4. The primary contributors are TEQs and heptachlor epoxide. The inhalation pathway ILCR was projected to be 6E-7.

For the deep groundwater ingestion pathway, the HI was computed to be 2.8. The primary contributors are heptachlor epoxide (HQ=2.5) and thallium (HQ=0.2). The inhalation pathway HI is 0.01.

COCs identified for this scenario based on their contribution to risk/hazard are TEQs, heptachlor epoxide, and thallium.

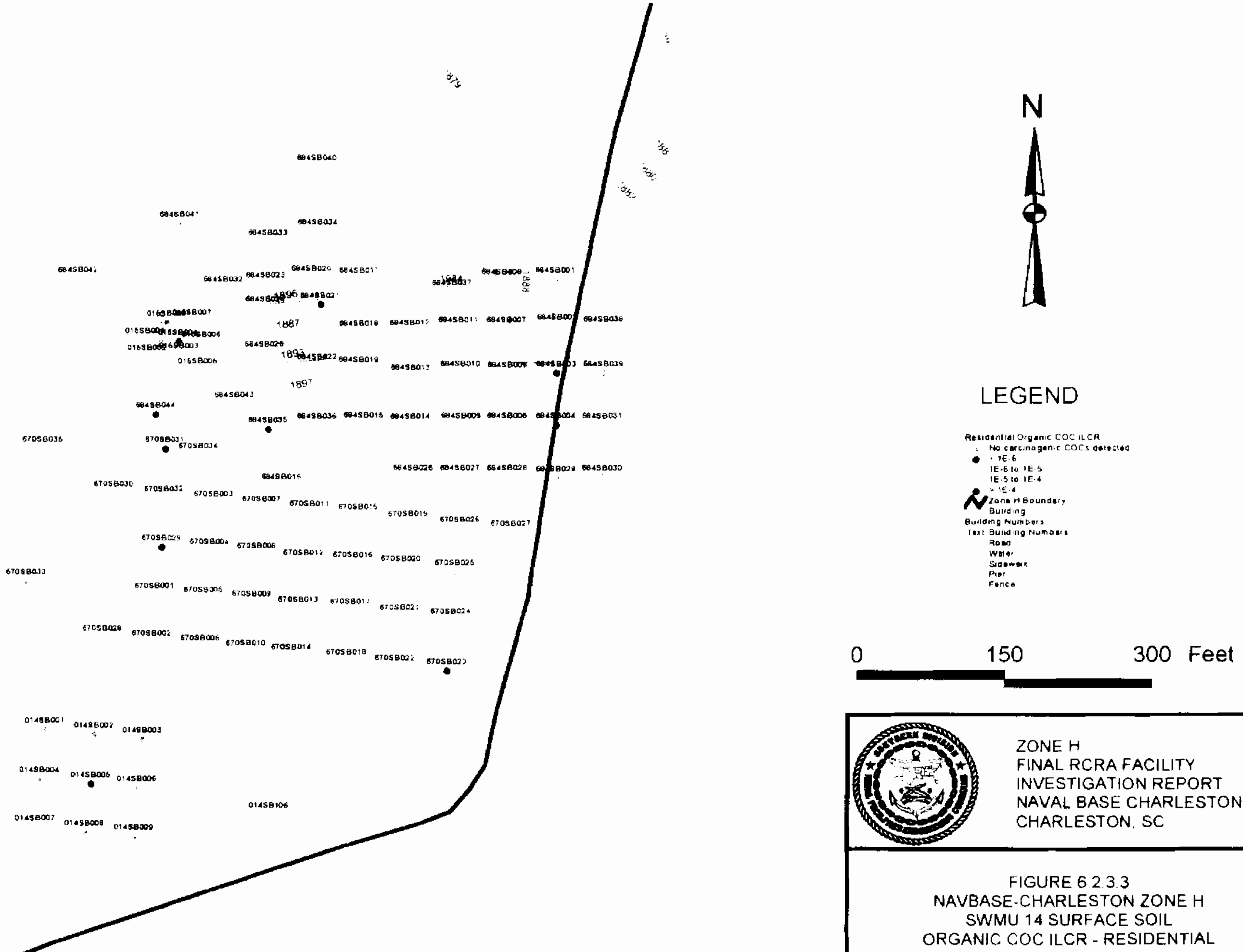
Current Site Workers

Deep groundwater is not a potable water source for combined SWMU 14 or other areas of Zone H. In the absence of a completed exposure pathway, no reported deep groundwater contamination poses a threat to human health.

COCs Identified

COCs were selected based on cumulative (all pathway) risk and hazard projected for SWMUs 14 and 15 and AOCs 670 and 684. COCs were identified for surface soil, shallow groundwater, and deep groundwater. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and an HI threshold of 1.0 (unity). In Zone H HHRAs, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater with a cumulative HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is relatively conservative because USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection algorithm presented was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process. Table 6.2.3.44 presents the COCs identified at combined SWMU 14 on a SWMU/AOC and medium-specific basis. A multimedia use scenario identifies COCs, as presented in Table 6.2.3.44. This scenario assumes exclusive use of either the shallow or deep water-bearing zone for potable or domestic water production.

Table 6.2.3.45 supports discussions regarding distribution and frequency of detection of COCs. Table 6.2.3.45 presents the projected residential risk and hazard associated with each surface soil COC on a location-specific basis. HQs are presented for the child resident and ILCR estimates are based on lifetime weighted average resident exposures. Figure 6.2.3.3 maps resident scenario based ILCR for organic COCs only.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 6.2.3.3
NAVBASE-CHARLESTON ZONE H
SWMU 14 SURFACE SOIL
ORGANIC COC ILCR - RESIDENTIAL

DATE 07/03/96	PROJ NAME RFI014.APR

Surface Soil

SWMU 14

Hypothetical Site Residents

Arsenic, BEQs, and beryllium were identified as COCs for surface soil based on their contribution to ILCR. Aluminum and vanadium were identified for the site resident scenario based on their contribution to potential noncarcinogenic hazard. Figure 6.2.3.3 illustrates calculated organic COC risk from surface soil for hypothetical site residents at combined SWMU 14.

Hypothetical Site Workers

Arsenic and beryllium were identified as COCs for surface soil based on their contribution to ILCR. No hazard-based COCs were identified for the site worker scenario.

The extent of the COCs identified in surface soil is briefly discussed below and illustrated by Figure 6.2.3.4. Residential risk-based concentrations were compared to each reported concentration for each COC identified above. BEQs were detected at only one of 10 sampling locations (014SB106) above the residential RBC. Arsenic, beryllium, and vanadium were not detected in any surface soil sample above the background UTLs, but were included due to Wilcoxon rank sum test results. Aluminum was detected in one sample (014SB010) at a concentration above its corresponding UTL (29,600 vs. 25,310 mg/kg). Because concentrations of these naturally occurring elements were comparable to background levels, their inclusion in risk/hazard projections is considered conservative.

SWMU 15

Hypothetical Site Residents

Arsenic and BEQs were identified as COCs for surface soil based on their contribution to ILCR. No additional COCs were identified for the site resident scenario based on their contribution to potential noncarcinogenic hazard. Figure 6.2.3.3 illustrates calculated organic COC risk from surface soil for hypothetical site residents at combined SWMU 14.

Hypothetical Site Workers

Arsenic and BEQs were identified as COCs for surface soil based on their contribution to ILCR. No hazard-based COCs were identified for the site worker scenario.

The extent of the COCs identified in surface soil is briefly discussed below and illustrated by Figure 6.2.3.4. BEQs were detected above the residential RBC at six locations (015SB001, 015SB003, 015SB004, 015SB005, 015SB006, and 015SB007). Arsenic was detected in two surface soil samples above both the residential RBC and the background UTL (015SB003 and 015SB004). The detection at location 015SB003 was only marginally higher than the background UTL (15 vs. 14.81 mg/kg). Because concentrations of this naturally occurring element were comparable to background levels, their inclusion in risk/hazard projections is considered conservative.

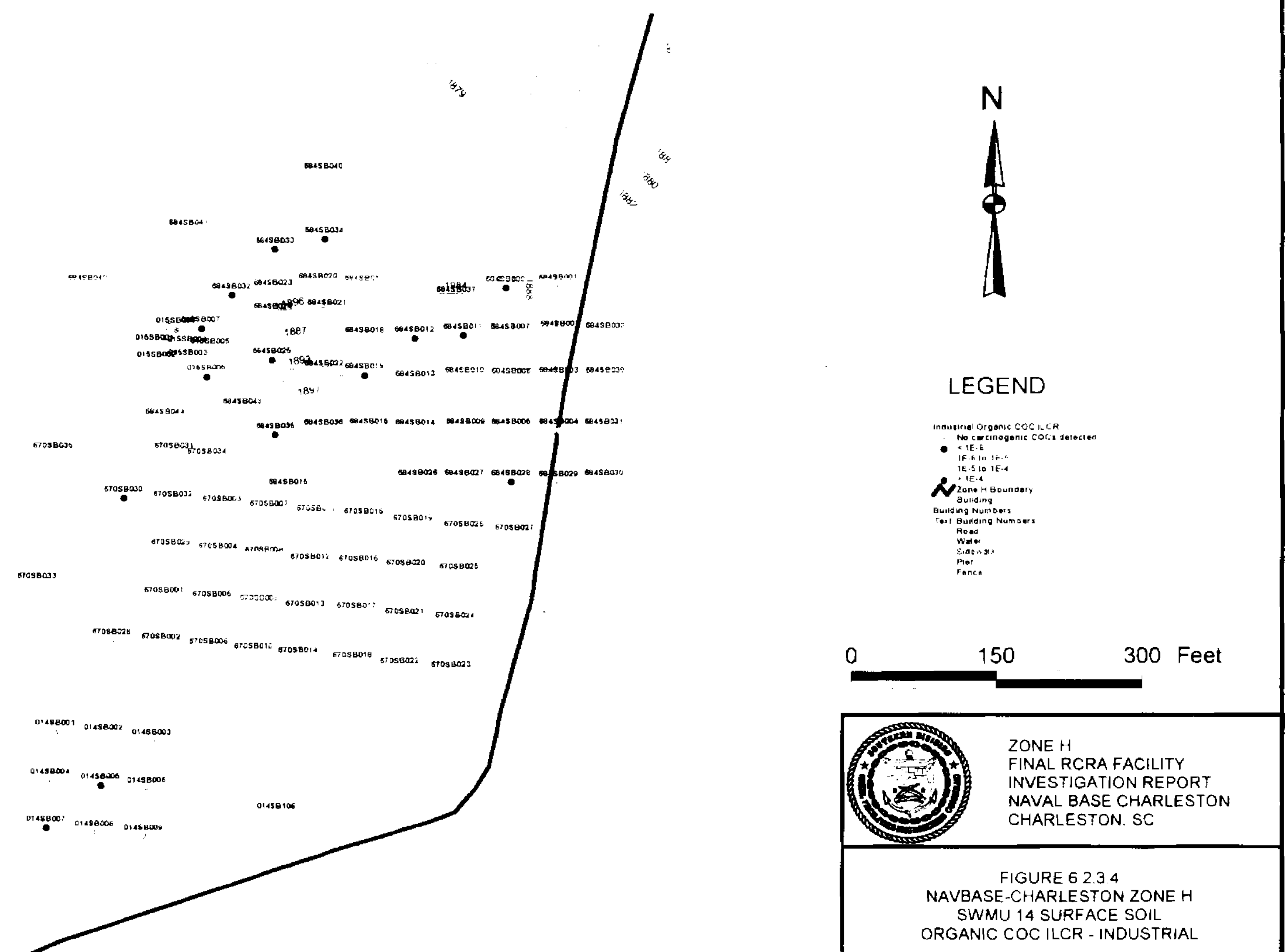
AOC 670

Hypothetical Site Residents:

Arsenic and BEQs were identified as COCs for surface soil based on their contribution to ILCR. Antimony and thallium were identified for the site resident scenario based on their contribution to potential noncarcinogenic hazard. Figure 6.2.3.3 illustrates calculated organic COC risk from surface soil for hypothetical site residents at combined SWMU 14.

Hypothetical Site Workers

Arsenic and BEQs were identified as COCs for surface soil based on their contribution to ILCR. No hazard-based COCs were identified for the site worker scenario.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 6.2.3.4
NAVBASE-CHARLESTON ZONE H
SWMU 14 SURFACE SOIL
ORGANIC COC ILCR - INDUSTRIAL

DATE 07/03/96 | PROJ NAME RFI014.APR

The extent of the COCs identified in surface soil is briefly discussed below and illustrated by Figure 6.2.3.4. BEQs were detected above the residential RBC at 15 of 34 locations. The ILCRs presented on Figure 6.2.3.4 represent the risk associated with BEQs at these locations. Two antimony results exceeding the residential RBC were reported. The limited extent of antimony reduces the probability of chronic exposure at the EPC. Arsenic was detected in six surface soil samples above both the residential RBC and the background UTL (670SB001, 670SB005, 670SB012, 670SB023, 670SB031, and 670SB032). Of these samples, only two locations had arsenic concentration more than 20% higher than the background UTL. This indicates that soil arsenic concentrations are similar to naturally occurring levels.

AOC 684

Hypothetical Site Residents

Arsenic, beryllium, and BEQs were identified as COCs for surface soil based on their contribution to ILCR. Antimony and thallium were identified for the site resident scenario based on their contribution to potential noncarcinogenic hazard. Figure 6.2.3.3 illustrates calculated organic COC risk from surface soil for hypothetical site residents at combined SWMU 14.

Hypothetical Site Workers

Arsenic, beryllium, and BEQs were identified as COCs for surface soil based on their contribution to ILCR. No hazard-based COCs were identified for the site worker scenario.

The extent of the COCs identified in surface soil is briefly discussed below and illustrated by Figure 6.2.3.4. BEQs were detected above the residential RBC at 24 of 44 locations. The ILCRs presented on Figure 6.2.3.3 primarily represent the risk associated with BEQs at these locations. Aroclor-1254 and 1260 were reported at two and three locations, respectively. These detections were in the northern section of AOC 684 and were widely distributed (locations 684SB007, 684SB032, and 684SB033).

Eight antimony results exceeding the residential RBC were reported. The limited extent of antimony reduces the probability of chronic exposure at the EPC. Although beryllium was detected in 25 of 32 surface soil samples collected, only one location (684SB009) had a concentration exceeding the background UTL (1.51 vs. 1.47 mg/kg). Arsenic was detected in 19 of 32 surface soil samples above both the residential RBC, but was only detected at one location (684SB026) above the background UTL. Because beryllium and arsenic concentrations were generally comparable to background levels, their inclusion in risk/hazard projections is considered conservative.

Shallow Groundwater

Hypothetical Site Residents

The carcinogenic COCs identified in shallow groundwater are TEQs and BEHP. Aluminum and vanadium were identified as COCs based on noncarcinogenic hazard contributions.

Hypothetical Site Workers

The carcinogenic COC identified in shallow groundwater is a TEQs. The COCs identified from HQs are aluminum and vanadium.

The extent of the COCs identified in shallow groundwater is briefly discussed below. TEQs and BEHP were detected in each first-quarter shallow groundwater sample. BEHP was absent in second-quarter samples, and laboratory contamination may account for the first-quarter results. Aluminum was detected in three of five second-quarter samples, and vanadium was detected in only one sample. Neither aluminum nor vanadium was detected in first-quarter shallow groundwater samples. Due to the hydrophobic nature of dioxins, they are not expected to migrate from soil to groundwater. It has been suspected that first-quarter results may reflect the influence of sediment entrained in the monitored zone during well installation. Third- and fourth-quarter results will confirm whether TEQs and BEHP are present in shallow groundwater. This review will facilitate responsible and sound risk management decisions.

Deep Groundwater

Hypothetical Site Residents

The carcinogenic COCs identified in shallow groundwater are TEQs, BEHP, chloroform, and heptachlor epoxide. Cadmium and thallium were identified as COCs based on noncarcinogenic hazard contributions.

Hypothetical Site Workers

The carcinogenic COCs identified in shallow groundwater are TEQs and heptachlor epoxide. The COC identified from its HQ is thallium.

The extent of the COCs identified in deep groundwater is briefly discussed below. TEQs were detected in each first-quarter shallow groundwater sample. BEHP was detected in two of five first-quarter deep groundwater samples but was absent in second-quarter samples. Laboratory contamination may account for the first-quarter BEHP results. Chloroform was detected in one first-quarter sample but absent in second-quarter samples, as was heptachlor epoxide. Thallium was detected in two first-quarter samples but was not detected in any second-quarter sample. Cadmium was the only deep groundwater COC detected during both quarterly sampling events.

Due to the hydrophobic nature of dioxins and heptachlor epoxide, they are not expected to migrate from soil to groundwater. It has been suspected that first-quarter results may reflect the influence of sediment entrained in the monitored zone during well installation. BEHP, chloroform, and thallium detections solely during first-round deep groundwater sampling raise suspicions as to whether results from this sampling round were representative of deep groundwater quality. Third- and fourth-quarter results will confirm whether TEQs, heptachlor epoxide, BEHP, chloroform, and thallium are present in deep groundwater. This review will facilitate responsible and sound risk management decisions.

6.2.3.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Site workers are exposed to surface soil when walking across the site or during maintenance. However, site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. Performing maintenance onsite 52 days per year would result in one-fifth the projected risk/hazard for site workers. If the exposure were adjusted to account for the percentage of time spent performing maintenance onsite, CDI (and thus risk/hazard estimates) would be much less than that presented in Section 6.2.3.3.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans designate Zone H as a marine cargo terminal. If this area were used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

No site features at combined SWMU 14 would have a substantial influence on potential exposure for future site workers. The entire investigative area comprises approximately 14 acres. Future site workers and residents would likely frequent only a portion of the total area.

Shallow groundwater is not currently used at combined SWMU 14 for potable or industrial purposes. A basewide system providing drinking and process water to buildings throughout

Zone H is to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The maximum concentrations reported in groundwater (shallow and deep) during either quarterly sampling event were used to calculate risk/hazard for all COPCs. The use of maximum reported concentrations would overestimate CDI and the resulting risk/hazard. In surface soil, UCLs were calculated for COPCs identified at AOCs 670 and 684.

Frequency of Detection and Spatial Distribution

SWMU 14 Surface Soil

BEQs were detected at only one of 10 sampling locations (014SB106) above the residential RBC. Arsenic, beryllium, and vanadium were not detected in any surface soil sample above their background UTLs. Wilcoxon rank sum tests resulted in their inclusion. Aluminum was detected in one sample (014SB010) at a concentration above its corresponding UTL (29,600 vs. 25,310 mg/kg). Because concentrations of these naturally occurring elements were comparable to background levels, their inclusion in risk/hazard projections is considered conservative. Based on these findings, the frequency of detection of most SWMU 14 surface soil COCs would indicate a low probability of chronic exposure at the applied EPC.

SWMU 15 Surface Soil

BEQs were detected above the residential RBC at six locations (015SB001, 015SB003, 015SB004, 015SB005, 015SB006, and 015SB007). Arsenic was detected in two surface soil samples above both the residential RBC and the background UTL (015SB003 and 015SB004). The detection at location 015SB003 was only marginally higher than the background UTL (15 vs. 14.81 mg/kg). Because concentrations of these naturally occurring elements were comparable to background levels, their inclusion in risk/hazard projections is considered conservative. Based on these findings, chronic exposure to arsenic above naturally occurring background levels would be improbable. BEQs are, however, sufficiently widespread to present a reasonable chance of chronic exposure, if not at the maximum concentration used as the EPC.

AOC 670 Surface Soil

BEQs were detected above the residential RBC at 15 of 34 locations. The ILCRs on Figure 6.2.3.3 represent the risk associated with BEQs at these locations. Two antimony results exceeding the residential RBC were reported. The limited extent of antimony reduces the probability of chronic exposure at the EPC. Arsenic was detected in six surface soil samples above both the residential RBC and the background UTL (670SB001, 670SB005, 670SB012, 670SB023, 670SB031, and 670SB032). Of these samples, only two locations had arsenic concentration more than 20% higher than the background UTL. This indicates that in most instances, soil arsenic concentrations are similar to naturally occurring levels.

AOC 684 Surface Soil

BEQs were detected above the residential RBC at 24 of 44 locations. The ILCRs on Figure 6.2.3.3 primarily represent the risk associated with BEQs at these locations. Aroclor-1254 and 1260 were reported at two and three locations in the northern section of AOC 684 and were widely distributed (locations 684SB007, 684SB032, and 684SB033).

Eight antimony results exceeding the residential RBC were reported. The limited extent of antimony reduces the probability of chronic exposure at the EPC. Although beryllium was detected in 25 of 32 surface soil samples collected, only one location (684SB009) had a concentration exceeding the background UTL (1.51 vs. 1.47 mg/kg). Arsenic was detected in 19 of 32 surface soil samples above both the residential RBC, but only detected at one location (684SB026) above the background UTL. Because concentrations of beryllium and arsenic were comparable to background levels in most cases, their inclusion in risk/hazard projections is considered conservative.

The probability of chronic exposure to antimony and Aroclors at the applied EPCs is low based on the observed distributions at AOC 684. Furthermore, exposure to beryllium at concentrations in excess of naturally occurring levels is unlikely based on the limited number of background exceedances. BEQs were detected at a sufficient frequency to conclude that chronic exposure is possible, and use of the UCL mean as the EPC should provide a reasonable approximation of exposure.

Potential Benzo(a)pyrene Equivalent Source

BEQs were detected frequently in surface soil in combined SWMU 14. There appears to be a correlation between elevated cPAH concentrations in surface soil and a black material with the consistency of cinders. This material has been used extensively across the zone for road base and general fill. Because it originated from coal burning, the detection of cPAHs in soil mixed with the material is not unexpected. The characteristics of the material including a cinder consistency would tend to minimize coingestion with native soil. The material was at the surface in some areas of SWMU 14 and buried beneath more recent soil fill in others. As a result, constructioning a comprehensive coal clinker distribution map was not possible. This material should, however, be considered in the risk management process.

Shallow Groundwater

Although BEHP was detected in samples from all five monitoring wells during the first quarterly sampling event, the maximum concentration detected was used as the EPC. This overestimates the hot spot's risk and hazard based on the assumption that the maximum concentration is the concentration for the whole SWMU. The absence of BEHP in second-quarter samples draws into question the potential chronicity of exposure through shallow groundwater pathways. TEQs presence in shallow groundwater may be confirmed or refuted by third- and fourth-quarter sampling results.

Deep Groundwater

In deep groundwater, heptachlor epoxide, BEHP, chloroform, and thallium were detected exclusively in first-quarter samples. Therefore, use of the maximum concentration as the EPC is highly conservative due to the improbability of chronic exposure. Furthermore, most COCs in deep groundwater were not detected in shallow groundwater. Therefore, there is no direct indication that the COCs identified in deep groundwater are associated with former disposal practices.

Elevated TPH results were reported in soil onsite. No groundwater sample contained detectable concentrations of TPH, indicating that the shallow aquifer is sufficiently protected under current conditions from soil-to-groundwater cross-media transport of TPH constituents.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC, reducing the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Beryllium and manganese exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding reference concentrations. Because they did not contribute to excess risk/hazard at the site, they were eliminated from formal assessment based on comparisons to the reference concentrations.

Although the future land use at this site is unknown, both the worker and residential exposure scenarios were assessed in this HHRA.

CT was not formally analyzed for surface soil, but a simplified approach was taken to assess the potential influences of its assumptions. The CT assumption for residential exposure duration is nine years compared to the 30-year assumption for RME. The CT exposure frequency assumption is 234 days/year compared to 350 days/year RME. If all other exposure assumptions remain fixed, applying the CT exposure duration and frequency would result in lifetime cancer risk projections and adult noncancer effects approximately 80% below the RME. For the child resident, the CT exposure duration is equal to RME and the same adjustment is made to exposure frequency. This translates into projections 34% below RME for child resident noncancer effects. At CT, the residential surface soil pathway related risk (incidental ingestion and dermal contact) would fall below the 1E-4 at each of the individual sites but would still be considerably higher than the 1E-6 point of departure. Additionally, all RME-based COCs would be retained. For SWMU 14, AOC 670, and AOC 684 the child resident surface soil pathway-related HIs would, however, fall below 1 under CT assumptions. Arsenic at SWMU 15 would be the only noncarcinogenic COC identified for any SWMU or AOC in combined SWMU 14.

Groundwater

Of the CPSSs screened and eliminated from formal assessment, none was reported at concentrations close to the corresponding RBCs (i.e., within approximately 10% of the RBC), reducing the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs.

CT was not formally analyzed for SWMU 14 shallow or deep groundwater, but a simplified approach was taken to assess the potential influences of CT assumptions. The CT assumption for residential exposure duration is nine years compared to the 30-year assumption for RME. The CT exposure frequency assumption is 234 days/year compared to 350 days/year RME. If all other exposure assumptions remain fixed, applying the CT exposure duration and frequency would result in risk projections approximately 80% below the RME. For the child resident, the CT and RME exposure duration are equal and the same adjustment is made to exposure frequency. This translates into projections 34% below RME for child resident noncancer effects. At CT, the residential shallow and deep groundwater pathway-related risk (incidental ingestion and inhalation) would fall below the 1E-4, but would still be considerably higher than the 1E-6 point of departure. The child resident shallow groundwater HIs would, however, fall from 2 to 1 under CT assumptions, and noncarcinogenic COCs would remain the same for combined SWMU 14 shallow groundwater. The deep groundwater HI under CT assumptions would remain above 1 for the resident child due to heptachlor epoxide only.

In consideration of the rather tenuous nature of most current shallow and deep groundwater COCs (and thus risk/hazard projections) third- and fourth-quarter results should confirm whether COCs are present in groundwater. This review will be imperative to reach responsible and sound risk management decisions.

6.2.3.7 Risk Summary

The risk and hazard posed by contaminants at combined SWMU 14 were assessed for the hypothetical site worker and the hypothetical future site resident under reasonable maximum exposure assumptions. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion and inhalation were evaluated for shallow and deep groundwater based on first- and second-quarter groundwater monitoring data. Table 6.2.3.46 summarizes risk for each pathway/receptor group evaluated for combined SWMU 14.

6.2.3.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident and adult site worker, as presented in Tables 6.2.3.47 and 6.2.3.48 for surface soil respectively. Hazard-based RGOs were calculated based on either the hypothetical child resident or the adult site worker, as noted in each of the corresponding tables.

Groundwater

Shallow groundwater RGOs based on site residents and site workers are shown in Tables 6.2.4.49 and 6.2.4.50, respectively. Deep groundwater RGOs based on site residents and site workers are shown in Tables 6.2.4.51 and 6.2.4.52, respectively.

RGOs for surface soil are presented in Tables 6.2.3.19 (residential) and 6.2.3.20 (worker), while groundwater RGOs are presented in Tables 6.2.3.21 (residential, shallow groundwater), 6.2.3.22 (residential, deep groundwater), and 6.2.3.23 (worker, deep groundwater). Residential RGOs were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens, while worker RGOs were based on the adult site worker in every case, as noted on the corresponding tables. Inclusion in an RGO table does not necessarily indicate that remedial action is warranted. RGOs are options to be considered when making risk management decisions which are not to be included in HHRA, according to RAGS.

Table 6.2.3.1
Methods Run at SWMU 14
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
014	B001	A	A	A	Y	Y	Y	Y	A	A	A					
014	B002	A	A	A	Y	Y	Y	Y	A	A	A					
014	B003	A	A	A	Y	Y	Y	Y	A	A	A					
014	B004	A	A	A	Y	Y	Y	Y	A	A	A					
014	B005	A	A	A	Y	Y	Y	Y	A	A	A					
014	B006	A	A	A	Y	Y	Y	Y	A	A	A					
014	B007	A	A	A	Y	Y	Y	Y	A	A	A					
014	B008	A	A	A	Y	Y	Y	Y	A	A	A					
014	B009	A	A	A	Y	Y	Y	Y	A	A	A					
014	B010	S														
014	B011	S														
014	B05A													Y	Y	Y
014	B106	S	S	S	Y					S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.3.2
Methods Run at SWMU 15
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
015	B001	S	S	S	Y					S						
015	B002	S	S	S	Y					S						
015	B003	S	S	S	Y					S						
015	B004	B	B	B	Y	Y	Y	Y	A	B	A					
015	B005		S													
015	B006		S													
015	B007		S													
015	B008		S													
015	B03A													Y	Y	Y
015	B04A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

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B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.3.3
Methods Run at AOC 670
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
670	B001	S	S	S	Y					S						
670	B002	S	S	S	Y					S						
670	B003	A	B	B	Y	Y	Y	Y	A	B	A					
670	B004	S	S	S	Y					S						
670	B005	S	S	S	Y					S						
670	B006	S	S	S	Y					S						
670	B007	S	S	S	Y					S						
670	B008	S	S	S	Y					S						
670	B009	S	S	S	Y					S						
670	B010	S	S	S	Y					S						
670	B011	S	S	S	Y					S						
670	B012	S	S	S	Y					S						
670	B013	B	B	B	Y	Y	Y	Y	A	B	A					
670	B014	S	S	S	Y					S						
670	B015	A	A	A	Y	Y	Y	Y	A	A	A					
670	B016	S	S	S	Y					S						
670	B017	S	S	S	Y					S						
670	B018	S	S	S	Y					S						
670	B019	A	A	A	Y		Y	Y	A	A	A					
670	B020	A	A	A	Y	Y	Y	Y	A	A	A					
670	B021	S	S	S	Y					S						
670	B022	S	S	S	Y					S						
670	B023	S	S	S	Y					S						
670	B024	S	S	S	Y					S						
670	B025	A			Y	Y	Y				A					
670	B026	A	A	A	Y	Y	Y	Y	A	A	A					
670	B027	A	A	A	Y	Y	Y	Y	A	A	A					
670	B028		S													
670	B029		S													
670	B030		S													
670	B031	A	B	A	Y	Y	Y	Y	A	A	A					
670	B032	A	A	A	Y	Y	Y	Y	A	A	A					
670	B033		S													

Table 6.2.3.3
Methods Run at AOC 670
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
670	B034		S													
670	B035		S													
670	B08A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

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	Blank value indicates this method of analysis was not performed

Table 6.2.3.4
Methods Run at AOC 684
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
684	B001	A	A	A	Y	Y	Y	Y	A	A	A					
684	B002	A	A	A	Y	Y	Y	Y	A	A	A					
684	B003	A	A	A	Y	Y	Y	Y	A	A	A					
684	B004	A	A	A	Y	Y	Y	Y	A	A	A					
684	B005	A	A	A	Y	Y	Y	Y	A	A	A					
684	B006	A	A	A	Y	Y	Y	Y	A	A	A					
684	B007	A	A	A	Y	Y	Y	Y	A	A	A					
684	B008	A	A	A	Y	Y	Y	Y	A	A	A					
684	B009	A	A	A	Y	Y	Y	Y	A	A	A					
684	B010	A	A	A	Y	Y	Y	Y	A	A	A					
684	B011	A	A	A	Y	Y	Y	Y	A	A	A					
684	B012	A	A	A	Y	Y	Y	Y	A	A	A					
684	B013	A	A	A	Y	Y	Y	Y	A	A	A					
684	B014	A	A	A	Y	Y	Y	Y	A	A	A					
684	B015	A	A	A	Y	Y	Y	Y	A	A	A					
684	B016	A	A	A	Y	Y	Y	Y	A	A	A					
684	B017	A	A	A	Y	Y	Y	Y	A	A	A					
684	B018	A	A	A	Y	Y	Y	Y	A	A	A					
684	B019	A	A	A	Y	Y	Y	Y	A	A	A					
684	B020	A	A	A	Y	Y	Y	Y	A	A	A					
684	B021	A	A	A	Y	Y	Y	Y	A	A	A					
684	B022	A	A	A	Y	Y	Y	Y	A	A	A					
684	B023	A	A	A	Y	Y	Y	Y	A	A	A					
684	B024	A	A	A	Y	Y	Y	Y	A	A	A					
684	B025	A	A	A	Y	Y	Y	Y	A	A	A					
684	B026	A	A	A	Y	Y	Y	Y	A	A	A					
684	B027	A	A	A	Y	Y	Y	Y	A	A	A					
684	B028	A	A	A	Y	Y	Y	Y	A	A	A					
684	B029	A	A	A	Y	Y	Y	Y	A	A	A					
684	B030	A	A	A	Y	Y	Y	Y	A	A	A					
684	B031	A	A	A	Y	Y	Y	Y	A	A	A					
684	B032		S							S						
684	B033		S							S						

Table 6.2.3.4
Methods Run at AOC 684
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
684	B034		S							S						
684	B035		S							S						
684	B036	A	B	A	Y	Y	Y	Y	A	B	A					
684	B037		S							S						
684	B038		S							S						
684	B039		S							S						
684	B040		S													
684	B041		S													
684	B042		S													
684	B043		S													
684	B044		S													
684	B21A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.3.5
Methods Run at SWMU 14 (Includes SWMU 15, AOC 670 and AOC 684)
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
014	W001	A	A	A	Y	Y	Y	Y	A	A						
014	W002	A	A	A	Y	Y	Y	Y	A	A	A					
014	W003	A	A	A	Y	Y	Y	Y	A	A						
014	W004	A	A	A	Y	Y	Y	Y	A	A						
014	W005	A	A	A	Y	Y	Y	Y	A	A						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.3.6
Methods Run at SWMU 14 (Includes SWMU 15, AOC 670 and AOC 684)
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
014	W001	S		S					S	S						
014	W002	S		S					S	S						
014	W003	S		S					S	S						
014	W004	S		S					S	S						
014	W005	S		S					S	S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.3.7
Methods Run at SWMU 14 (Includes SWMU 15, AOC 670 and AOC 684)
Deep Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
014	W01D	A	A	A	Y	Y	Y	Y	A	A						
014	W02D	A	A	A	Y	Y	Y	Y	A	A	A					
014	W03D	A	A	A	Y	Y	Y	Y	A	A						
014	W04D	A	A	A	Y	Y	Y	Y	A	A						
014	W05D	A	A	A	Y	Y	Y	Y		A						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.3.8
Methods Run at SWMU 14 (Includes SWMU 15, AOC 670 and AOC 684)
Deep Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
014	W01D	S		S					S	S						
014	W02D	S		S					S	S						
014	W03D	S		S					S	S						
014	W04D	S		S					S	S						
014	W05D	S		S					S	S						

METHODS:

Metal: TAL (Target Analyte List) Metals plus tin:
Methods: 6000/7000 Series
VOA: Volatile Organics: Method 8240
SVOA: Semi-volatile Organics: Method 8270
Cn: Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac: Hexavalent Chromium: Method 7195
Dioxin: Dioxins: Method 8290
Oppe: Organophosphate Pesticides: Method 8140
Herb: Chlorinated Herbicides: Method 8150
Pest: Chlorinated Pesticides: Method 8080
Tph: Total Petroleum Hydrocarbons: Method 418.1
Tph GR: Total Petroleum Hydrocarbons with Gasoline Range Organics
Extraction Method 5030, GC Method 8015
Tph DR: Total Petroleum Hydrocarbons with Diesel Range Organics
Extraction Method 3550, GC Method 8100
Wq I: Wet Chemistry I Parameters
Wq II: Wet Chemistry II Parameters
Phys: Physical Chemistry Parameters

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.3.9
SWMU 14
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/KG	1/ 10	330.00 -	330.00	130.000 -	130.000	130.000	470000.0000			
* Aluminum	MG/KG	3/ 3			14800.000 -	29600.000	23000.000	7800.0000	3	25310.000	1
Anthracene	UG/KG	1/ 10	330.00 -	330.00	190.000 -	190.000	190.000	2300000.0000			
Antimony	MG/KG	1/ 12	1.10 -	11.30	2.000 -	2.000	2.000	3.1000			
Arsenic	MG/KG	2/ 12	10.70 -	19.30	11.900 -	13.600	12.750	0.3700	2	14.810	
Barium	MG/KG	5/ 12	4.50 -	34.70	21.900 -	29.000	24.420	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	1/ 10	330.00 -	330.00	210.000 -	210.000	210.000	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	10/ 10			48.187 -	925.210	140.039	88.0000	1		
Benzo(a)anthracene	UG/KG	3/ 10	330.00 -	330.00	62.100 -	580.000	236.933				
Benzo(b)fluoranthene	UG/KG	2/ 10	330.00 -	330.00	84.100 -	560.000	322.050				
Chrysene	UG/KG	3/ 10	330.00 -	330.00	78.400 -	610.000	259.400				
Indeno(1,2,3-cd)pyrene	UG/KG	1/ 10	330.00 -	330.00	210.000 -	210.000	210.000				
Benzo(k)fluoranthene	UG/KG	2/ 10	330.00 -	330.00	57.600 -	960.000	508.800				
Benzo(a)pyrene	UG/KG	2/ 10	330.00 -	330.00	60.100 -	780.000	420.050				
Beryllium	MG/KG	8/ 12	0.84 -	1.10	0.820 -	1.200	0.977	0.1500	8	1.470	
2-Butanone (MEK)	UG/KG	1/ 10	10.00 -	39.00	4.600 -	4.600	4.600	4700000.0000			
Calcium	MG/KG	3/ 3			59000.000 -	183000.000	141000.000				
Carbon disulfide	UG/KG	1/ 10	5.00 -	8.00	3.400 -	3.400	3.400	780000.0000			
* Chromium	MG/KG	12/ 12			38.300 -	91.000	62.600	39.0000	11	85.650	1
Cobalt	MG/KG	3/ 12	4.40 -	6.00	3.300 -	6.600	5.266	470.0000		5.860	2
Copper	MG/KG	9/ 12	14.10 -	17.00	19.200 -	42.400	24.566	290.0000		27.600	1
2,4-D	UG/KG	4/ 9	50.00 -	50.00	59.300 -	68.500	63.400	78000.0000			
4,4'-DDE	UG/KG	4/ 10	3.30 -	3.30	2.700 -	4.400	3.875	1900.0000			
4,4'-DDT	UG/KG	5/ 10	3.30 -	10.00	2.500 -	7.700	3.920	1900.0000			
1,1-Dichloroethene	UG/KG	2/ 10	5.00 -	8.00	1.800 -	2.500	2.150	1100.0000			
Dioxin (TCDD TEQ)	PG/G	9/ 9			7.884 -	22.357	13.822	1000.0000			
Endrin	UG/KG	1/ 10	3.30 -	5.00	2.600 -	2.600	2.600	2300.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	2/ 10	330.00 -	550.00	63.600 -	89.200	76.400	46000.0000			
Fluoranthene	UG/KG	2/ 10	330.00 -	330.00	44.800 -	1000.000	522.400	310000.0000			
Fluorene	UG/KG	1/ 10	330.00 -	550.00	73.800 -	73.800	73.800	310000.0000			
Iron	MG/KG	3/ 3			14200.000 -	31800.000	23266.666			30910.000	1
* Lead	MG/KG	9/ 12	24.80 -	44.60	83.000 -	915.000	384.316	400.0000j	3	118.000	7
Magnesium	MG/KG	3/ 3			5040.000 -	7520.000	6236.666			9592.000	
Manganese	MG/KG	3/ 3			236.000 -	473.000	366.666	39.0000	3	636.400	

Table 6.2.3.9
SWMU 14
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Mercury	MG/KG	11/ 12	0.04 -	0.04	0.050 -	0.200	0.112	2.3000		0.490	
2-Methylnaphthalene	UG/KG	1/ 10	330.00 -	550.00	44.600 -	44.600	44.600	310000.0000i			
Nickel	MG/KG	4/ 12	16.50 -	31.70	18.800 -	26.700	22.275	160.0000		33.380	
Phenanthrene	UG/KG	2/ 10	330.00 -	330.00	54.300 -	690.000	372.150	310000.0000k			
Potassium	MG/KG	3/ 3			2060.000 -	2410.000	2240.000				
Pyrene	UG/KG	3/ 10	330.00 -	330.00	61.500 -	1000.000	381.533	230000.0000			
Selenium	MG/KG	10/ 12	0.40 -	1.40	0.640 -	6.200	1.899	39.0000		2.000	2
Silver	MG/KG	1/ 12	0.23 -	1.90	1.800 -	1.800	1.800	39.0000			
Sodium	MG/KG	3/ 3			364.000 -	597.000	499.666				
2,4,5-T	UG/KG	4/ 9	10.00 -	10.00	9.800 -	17.500	14.000	78000.0000			
2,4,5-TP (Silvex)	UG/KG	5/ 9	10.00 -	10.00	7.900 -	13.100	10.040	63000.0000			
* Petroleum Hydrocarbons, TPH	MG/KG	1/ 9	79.00 -	89.00	150.000 -	150.000	150.000	10.0000	1		
Thallium	MG/KG	1/ 12	0.34 -	0.99	0.550 -	0.550	0.550	0.6300		0.630	
Toluene	UG/KG	8/ 10	5.00 -	8.00	3.600 -	57.700	21.218	1600000.0000			
1,2,3-Trichloropropane	UG/KG	1/ 9	5.00 -	5.00	91.200 -	91.200	91.200	240.0000			
Vanadium	MG/KG	12/ 12			40.400 -	71.900	61.300	55.0000	9	77.380	
Xylene (total)	UG/KG	6/ 10	5.00 -	8.00	2.000 -	5.500	3.533	16000000.0000			
Zinc	MG/KG	11/ 12	103.00 -	103.00	77.000 -	103.000	88.509	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.3.10
SWMU 15
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/KG	1/ 8	350.00 - 470.00	190.000 - 190.000	190.000	470000.0000			
Acetone	UG/KG	4/ 4		13.000 - 69.000	36.250	780000.0000			
Aluminum	MG/KG	4/ 4		2600.000 - 16500.000	7607.500	7800.0000	1	25310.000	
Anthracene	UG/KG	1/ 8	350.00 - 470.00	182.000 - 182.000	182.000	2300000.0000			
* Arsenic	MG/KG	4/ 4		3.600 - 53.100	19.525	0.3700	4	14.810	2
alpha-BHC	UG/KG	1/ 4	3.00 - 5.00	1.400 - 1.400	1.400	100.0000			
Barium	MG/KG	2/ 4	0.38 - 0.39	2.900 - 29.300	16.100	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	3/ 8	350.00 - 470.00	150.000 - 846.500	395.500	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	8/ 8		216.552 - 2028.440	565.328	88.0000	8		
Benzo(a)anthracene	UG/KG	5/ 8	350.00 - 450.00	82.000 - 980.000	354.400				
Benzo(b)fluoranthene	UG/KG	5/ 8	350.00 - 410.00	100.000 - 1365.000	489.000				
Chrysene	UG/KG	6/ 8	350.00 - 370.00	85.000 - 990.000	354.166				
Dibenzo(a,h)anthracene	UG/KG	1/ 8	350.00 - 470.00	304.000 - 304.000	304.000				
Indeno(1,2,3-cd)pyrene	UG/KG	3/ 8	350.00 - 470.00	140.000 - 789.500	369.833				
Benzo(k)fluoranthene	UG/KG	3/ 8	350.00 - 470.00	82.000 - 1000.000	447.333				
Benzo(a)pyrene	UG/KG	6/ 8	350.00 - 370.00	96.000 - 1400.000	407.666				
Beryllium	MG/KG	4/ 4		0.190 - 0.805	0.481	0.1500	4	1.470	
Cadmium	MG/KG	4/ 4		0.470 - 1.000	0.712	3.9000		1.050	
Calcium	MG/KG	4/ 4		79600.000 - 275000.000	201150.000				
Chromium	MG/KG	4/ 4		21.100 - 50.950	31.212	39.0000	1	85.650	
Cobalt	MG/KG	4/ 4		3.400 - 5.500	4.375	470.0000		5.860	
Copper	MG/KG	4/ 4		7.100 - 55.000	20.950	290.0000		27.600	1
4,4'-DDD	UG/KG	1/ 4	7.00 - 10.00	12.200 - 12.200	12.200	2700.0000			
4,4'-DDE	UG/KG	1/ 4	3.00 - 5.00	3.300 - 3.300	3.300	1900.0000			
4,4'-DDT	UG/KG	1/ 4	7.00 - 10.00	17.400 - 17.400	17.400	1900.0000			
Dibenzofuran	UG/KG	1/ 8	350.00 - 470.00	54.700 - 54.700	54.700	31000.0000			
Dieldrin	UG/KG	1/ 4	3.00 - 5.00	10.000 - 10.000	10.000	40.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1		9.960 - 9.960	9.960	1000.0000			
Endosulfan I	UG/KG	1/ 4	3.00 - 5.00	1.800 - 1.800	1.800	47000.0000			
Endosulfan II	UG/KG	1/ 4	7.00 - 10.00	6.200 - 6.200	6.200	47000.0000			
Endrin	UG/KG	1/ 4	3.00 - 5.00	5.600 - 5.600	5.600	2300.0000			
Endrin aldehyde	UG/KG	1/ 4	7.00 - 10.00	22.000 - 22.000	22.000	2300.0000h			
bis(2-Ethylhexyl)phthalate	UG/KG	2/ 8	350.00 - 470.00	91.000 - 156.000	123.500	46000.0000			
Fluoranthene	UG/KG	6/ 8	350.00 - 370.00	110.000 - 1030.000	331.666	310000.0000			

Table 6.2.3.10
SWMU 15
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Fluorene	UG/KG	1/ 8	350.00 - 470.00	87.600 - 87.600	87.600	310000.0000			
Heptachlor epoxide	UG/KG	1/ 4	3.00 - 5.00	7.300 - 7.300	7.300	70.0000			
Iron	MG/KG	4/ 4		4360.000 - 28000.000	13842.500			30910.000	
Lead	MG/KG	3/ 4	7.30 - 7.30	21.000 - 77.750	40.016	400.0000j		118.000	
Magnesium	MG/KG	4/ 4		3350.000 - 4480.000	3785.000			9592.000	
Manganese	MG/KG	4/ 4		197.000 - 506.000	384.000	39.0000	4	636.400	
Mercury	MG/KG	4/ 4		0.020 - 0.160	0.085	2.3000		0.490	
Nickel	MG/KG	4/ 4		4.900 - 16.500	10.050	160.0000		33.380	
Parathion	UG/KG	1/ 1		26.400 - 26.400	26.400	47000.0000			
Phenanthrene	UG/KG	2/ 8	350.00 - 470.00	190.000 - 571.000	380.500	310000.0000k			
Potassium	MG/KG	3/ 4	400.00 - 400.00	711.000 - 1460.000	1070.333				
Pyrene	UG/KG	6/ 8	350.00 - 370.00	100.000 - 1085.000	337.500	230000.0000			
Selenium	MG/KG	1/ 4	1.80 - 3.00	1.200 - 1.200	1.200	39.0000		2.000	
Sodium	MG/KG	4/ 4		153.000 - 233.000	191.250				
Toluene	UG/KG	2/ 4	5.00 - 6.00	3.600 - 9.000	6.300	1600000.0000			
Vanadium	MG/KG	4/ 4		11.900 - 51.700	29.225	55.0000		77.380	
Zinc	MG/KG	4/ 4		51.500 - 166.500	86.375	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- h Endrin used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.3.11
AOC 670
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/KG	7/ 34	330.00 - 520.00	73.200 - 3145.000	844.028	470000.0000			
Acetone	UG/KG	4/ 28	10.00 - 56.50	36.000 - 78.000	56.000	780000.0000			
Aldrin	UG/KG	2/ 28	1.70 - 5.00	1.700 - 1.700	1.700	38.0000			
Aluminum	MG/KG	20/ 20		3220.000 - 21700.000	12100.500	7800.0000	15	25310.000	
Anthracene	UG/KG	8/ 34	330.00 - 520.00	14.300 - 4495.000	965.456	2300000.0000			
* Antimony	MG/KG	2/ 29	1.20 - 167.00	9.500 - 11.400	10.450	3.1000	2		
* Arsenic	MG/KG	27/ 29	9.90 - 13.70	7.000 - 69.000	13.503	0.3700	27	14.810	6
Barium	MG/KG	9/ 29	0.11 - 17.70	3.900 - 31.800	18.400	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	9/ 34	330.00 - 510.00	150.000 - 10750.000	1834.333	310000.0000			
* Benzo(a)pyrene Equivalents	UG/KG	34/ 34		93.060 - 27882.800	1490.970	88.0000	34		
Benzo(a)anthracene	UG/KG	14/ 34	330.00 - 510.00	34.500 - 14800.000	1935.421				
Benzo(b)fluoranthene	UG/KG	12/ 34	330.00 - 510.00	50.400 - 16250.000	2307.758				
Chrysene	UG/KG	16/ 34	330.00 - 510.00	49.800 - 16300.000	1846.443				
Dibenzo(a,h)anthracene	UG/KG	8/ 34	330.00 - 510.00	110.000 - 3850.000	853.750				
Indeno(1,2,3-cd)pyrene	UG/KG	9/ 34	309.00 - 510.00	140.000 - 8965.000	1629.666				
Benzo(k)fluoranthene	UG/KG	12/ 34	330.00 - 510.00	48.100 - 26500.000	3130.266				
Benzo(a)pyrene	UG/KG	15/ 34	330.00 - 510.00	53.100 - 19750.000	2287.140				
Beryllium	MG/KG	28/ 29	0.92 - 0.92	0.320 - 1.200	0.695	0.1500	28	1.470	
Cadmium	MG/KG	11/ 29	0.14 - 1.70	0.350 - 3.600	1.033	3.9000		1.050	4
Calcium	MG/KG	20/ 20		84900.000 - 271000.000	184140.000				
Carbon disulfide	UG/KG	1/ 28	5.00 - 9.00	3.500 - 3.500	3.500	780000.0000			
alpha-Chlordane	UG/KG	1/ 28	1.70 - 5.00	1.200 - 1.200	1.200	470.0000			
gamma-Chlordane	UG/KG	1/ 28	1.70 - 5.00	2.200 - 2.200	2.200	470.0000			
Chromium	MG/KG	29/ 29		34.300 - 74.200	52.270	39.0000	28	85.650	
Cobalt	MG/KG	20/ 29	2.00 - 4.80	1.800 - 6.600	3.970	470.0000		5.860	3
Copper	MG/KG	24/ 29	8.20 - 24.10	7.900 - 21.400	15.041	290.0000		27.600	
2,4-D	UG/KG	2/ 9	50.00 - 50.00	45.900 - 47.000	46.450	78000.0000			
4,4'-DDE	UG/KG	2/ 28	2.00 - 5.00	2.000 - 4.000	3.000	1900.0000			
4,4'-DDT	UG/KG	2/ 28	3.30 - 10.00	5.400 - 7.600	6.500	1900.0000			
Dibenzofuran	UG/KG	3/ 34	330.00 - 520.00	300.000 - 1340.000	750.000	31000.0000			
Dibromochloromethane	UG/KG	1/ 28	5.00 - 9.00	7.000 - 7.000	7.000	7600.0000			
Dieldrin	UG/KG	1/ 28	2.00 - 5.00	6.800 - 6.800	6.800	40.0000			
Dioxin (TCDD TEQ)	PG/G	10/ 10		2.346 - 15.174	7.791	1000.0000			
Endosulfan II	UG/KG	1/ 28	3.30 - 10.00	2.900 - 2.900	2.900	47000.0000			

Table 6.2.3.11
AOC 670
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Endrin	UG/KG	1/ 28	2.00 -	5.00	3.500 -	3.500	3.500	2300.0000			
Endrin aldehyde	UG/KG	2/ 28	3.30 -	10.00	4.600 -	6.100	5.350	2300.0000h			
bis(2-Ethylhexyl)phthalate	UG/KG	2/ 34	330.00 -	1100.00	110.000 -	800.000	455.000	46000.0000			
Fluoranthene	UG/KG	16/ 34	330.00 -	510.00	48.400 -	24600.000	2517.493	310000.0000			
Fluorene	UG/KG	3/ 34	330.00 -	520.00	490.000 -	2190.000	1193.333	310000.0000			
* Indeterminate Lubricating Oil	UG/KG	1/ 1			150000.000 -	150000.000	150000.000	10.0000	1		
Iron	MG/KG	20/ 20			4830.000 -	25500.000	13282.500			30910.000	
* Lead	MG/KG	20/ 29	7.70 -	16.30	16.500 -	20900.000	1213.790	400.0000j	3	118.000	4
Magnesium	MG/KG	20/ 20			4410.000 -	6960.000	5431.500			9592.000	
Manganese	MG/KG	20/ 20			42.400 -	418.000	196.365	39.0000	20	636.400	
Mercury	MG/KG	22/ 29	0.03 -	0.22	0.030 -	0.160	0.076	2.3000		0.490	
Methoxychlor	UG/KG	1/ 28	17.00 -	50.00	13.500 -	13.500	13.500	39000.0000			
Methylene chloride	UG/KG	10/ 28	5.00 -	65.00	11.000 -	29.000	18.200	85000.0000			
2-Methylnaphthalene	UG/KG	1/ 34	330.00 -	520.00	260.000 -	260.000	260.000	310000.0000i			
Naphthalene	UG/KG	3/ 34	330.00 -	520.00	110.000 -	585.000	305.000	310000.0000			
Nickel	MG/KG	28/ 29	20.90 -	20.90	12.400 -	29.000	20.205	160.0000		33.380	
Parathion	UG/KG	2/ 9	23.40 -	33.00	24.100 -	24.100	24.100	47000.0000			
Phenanthrene	UG/KG	12/ 34	330.00 -	510.00	49.200 -	18250.000	2490.516	310000.0000k			
Potassium	MG/KG	20/ 20			724.000 -	2250.000	1532.700				
Pyrene	UG/KG	15/ 34	330.00 -	510.00	42.300 -	22800.000	2582.506	230000.0000			
Selenium	MG/KG	20/ 29	1.30 -	3.20	0.820 -	2.300	1.773	39.0000		2.000	9
Sodium	MG/KG	20/ 20			328.000 -	1030.000	599.700				
2,4,5-TP (Silvex)	UG/KG	5/ 9	10.00 -	18.00	9.700 -	23.800	13.520	63000.0000			
* Thallium	MG/KG	3/ 29	0.20 -	2.70	0.480 -	1.400	0.900	0.6300	2	0.630	2
Toluene	UG/KG	12/ 28	5.00 -	9.00	1.900 -	116.000	20.083	1600000.0000			
Vanadium	MG/KG	29/ 29			19.500 -	68.300	42.584	55.0000	6	77.380	
Xylene (total)	UG/KG	3/ 28	5.00 -	9.00	2.000 -	4.600	3.233	16000000.0000			
Zinc	MG/KG	21/ 29	43.20 -	69.80	29.500 -	95.000	70.269	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- h Endrin used as surrogate
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.3.12
AOC 684
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/KG	10/ 44	330.00 - 1660.00	28.700 - 2800.000	683.230	470000.0000			
Acenaphthylene	UG/KG	1/ 44	330.00 - 3300.00	286.000 - 286.000	286.000	470000.0000e			
Acetone	UG/KG	2/ 32	10.00 - 129.00	7.600 - 97.400	52.500	780000.0000			
Anthracene	UG/KG	11/ 44	330.00 - 1660.00	66.600 - 4400.000	780.318	2300000.0000			
* Antimony	MG/KG	8/ 32	1.10 - 11.30	4.600 - 12.400	7.975	3.1000	8		
* Aroclor-1254	UG/KG	2/ 39	33.00 - 330.00	50.000 - 160.000	105.000	83.0000	1		
* Aroclor-1260	UG/KG	3/ 39	33.00 - 330.00	60.000 - 376.000	169.000	83.0000	1		
* Arsenic	MG/KG	19/ 32	0.56 - 18.60	0.890 - 16.300	7.767	0.3700	19	14.810	1
delta-BHC	UG/KG	3/ 32	1.70 - 17.00	1.200 - 1.700	1.433	490.0000l			
Barium	MG/KG	24/ 32	0.11 - 34.30	7.400 - 121.000	25.483	550.0000		40.330	2
Benzo(g,h,i)perylene	UG/KG	19/ 44	330.00 - 1650.00	72.000 - 5520.000	1321.157	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	44/ 44		72.209 - 29871.000	2252.513	88.0000	24		
Benzo(a)anthracene	UG/KG	24/ 44	330.00 - 1650.00	56.000 - 20000.000	2511.108				
Benzo(b)fluoranthene	UG/KG	24/ 44	330.00 - 1650.00	72.900 - 16000.000	2557.337				
Chrysene	UG/KG	24/ 44	330.00 - 1650.00	46.400 - 21000.000	3107.687				
Dibenzo(a,h)anthracene	UG/KG	11/ 44	330.00 - 1650.00	62.000 - 3640.000	995.109				
Indeno(1,2,3-cd)pyrene	UG/KG	18/ 44	330.00 - 1650.00	74.000 - 8590.000	1450.616				
Benzo(k)fluoranthene	UG/KG	24/ 44	330.00 - 1650.00	48.300 - 17000.000	2177.700				
Benzo(a)pyrene	UG/KG	23/ 44	330.00 - 1660.00	61.600 - 22000.000	3082.243				
* Beryllium	MG/KG	25/ 32	0.05 - 1.40	0.130 - 1.510	0.642	0.1500	24	1.470	1
2-Butanone (MEK)	UG/KG	1/ 32	10.00 - 10.00	3.900 - 3.900	3.900	4700000.0000			
Cadmium	MG/KG	8/ 32	0.14 - 1.40	0.290 - 2.430	1.261	3.9000		1.050	4
Carbon disulfide	UG/KG	1/ 32	5.00 - 5.00	1.200 - 1.200	1.200	780000.0000			
alpha-Chlordane	UG/KG	9/ 32	1.70 - 17.00	1.200 - 24.700	7.888	470.0000			
gamma-Chlordane	UG/KG	7/ 32	1.70 - 17.00	1.700 - 52.500	15.992	470.0000			
Chlorobenzilate	UG/KG	3/ 32	33.00 - 330.00	25.600 - 160.000	72.466	2400.0000			
Chromium	MG/KG	32/ 32		3.600 - 57.800	30.159	39.0000	13	85.650	
Cobalt	MG/KG	10/ 32	0.53 - 7.90	1.100 - 6.100	3.360	470.0000		5.860	1
Copper	MG/KG	21/ 32	0.31 - 33.60	3.700 - 79.700	23.228	290.0000		27.600	6
Cyanide	MG/KG	1/ 32	0.90 - 2.00	0.002 - 0.002	0.002	160.0000			
2,4-D	UG/KG	10/ 32	50.00 - 50.00	35.100 - 61.300	44.440	78000.0000			
4,4'-DDD	UG/KG	8/ 32	3.30 - 33.00	2.400 - 5.000	4.000	2700.0000			
4,4'-DDE	UG/KG	12/ 32	3.30 - 33.00	2.300 - 19.700	7.050	1900.0000			
4,4'-DDT	UG/KG	18/ 32	3.30 - 33.00	2.400 - 50.000	14.266	1900.0000			

Table 6.2.3.12
AOC 684
Surface Soil

	Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
	Dibenzofuran	UG/KG	4/ 44	330.00 -	3300.00	110.000 -	1000.000	392.250	31000.0000			
	1,1-Dichloroethene	UG/KG	1/ 32	5.00 -	5.00	2.200 -	2.200	2.200	1100.0000			
	Dieldrin	UG/KG	3/ 32	3.30 -	33.00	2.400 -	3.000	2.766	40.0000			
*	7,12-Dimethybenz(a)anthracen	UG/KG	1/ 32	330.00 -	3300.00	1730.000 -	1730.000	1730.000	88.0000[d]	1		
	Dioxin (TCDD TEQ)	PG/G	32/ 32			0.831 -	15.953	7.543	1000.0000			
	Endosulfan I	UG/KG	1/ 32	1.70 -	17.00	1.400 -	1.400	1.400	47000.0000			
	Endosulfan II	UG/KG	2/ 32	3.30 -	33.00	2.500 -	4.100	3.300	47000.0000			
	Endosulfan sulfate	UG/KG	1/ 32	3.30 -	33.00	3.800 -	3.800	3.800	47000.0000[g]			
	Endrin	UG/KG	1/ 32	3.30 -	33.00	2.200 -	2.200	2.200	2300.0000			
	Endrin aldehyde	UG/KG	3/ 32	3.30 -	33.00	2.200 -	4.200	3.100	2300.0000[h]			
	bis(2-Ethylhexyl)phthalate	UG/KG	11/ 44	330.00 -	4700.00	45.700 -	320.000	93.945	46000.0000			
	Fluoranthene	UG/KG	28/ 44	330.00 -	1650.00	46.300 -	18000.000	1653.210	310000.0000			
	Fluorene	UG/KG	5/ 44	330.00 -	3300.00	55.000 -	1500.000	499.400	310000.0000			
	Heptachlor	UG/KG	2/ 32	1.70 -	17.00	1.100 -	1.400	1.250	140.0000			
	Heptachlor epoxide	UG/KG	6/ 32	1.70 -	17.00	1.400 -	16.200	6.608	70.0000			
*	Indeterminate Lubricating Oil	UG/KG	1/ 1			38000.000 -	38000.000	38000.000	10.0000	1		
	Isodrin	UG/KG	2/ 32	3.30 -	33.00	3.200 -	3.300	3.250				
	Lead	MG/KG	25/ 32	11.50 -	43.00	3.900 -	117.000	37.722	400.0000[j]		118.000	
	Mercury	MG/KG	11/ 32	0.02 -	0.35	0.040 -	0.240	0.125	2.3000		0.490	
	Methoxychlor	UG/KG	1/ 32	17.00 -	170.00	12.600 -	12.600	12.600	39000.0000			
	Methylene chloride	UG/KG	3/ 32	5.90 -	63.00	27.100 -	212.000	105.733	85000.0000			
	2-Methylnaphthalene	UG/KG	2/ 44	330.00 -	2600.00	62.800 -	524.000	293.400	310000.0000[i]			
	Naphthalene	UG/KG	4/ 44	330.00 -	1660.00	75.800 -	550.000	280.450	310000.0000			
	Nickel	MG/KG	15/ 32	1.00 -	19.00	4.100 -	23.000	12.080	160.0000		33.380	
	Parathion	UG/KG	6/ 32	19.10 -	36.40	21.300 -	37.500	29.783	47000.0000			
	Phenanthrene	UG/KG	22/ 44	330.00 -	1650.00	54.600 -	14000.000	1430.136	310000.0000[k]			
	Pyrene	UG/KG	28/ 44	330.00 -	1650.00	47.800 -	22000.000	2200.007	230000.0000			
	Selenium	MG/KG	20/ 32	0.27 -	0.85	0.130 -	2.700	0.878	39.0000		2.000	4
	2,4,5-T	UG/KG	16/ 32	10.00 -	10.00	6.500 -	18.600	10.318	78000.0000			
	2,4,5-TP (Silvex)	UG/KG	14/ 32	10.00 -	10.00	5.600 -	26.300	12.650	63000.0000			
*	Petroleum Hydrocarbons, TPH	MG/KG	11/ 31	50.00 -	90.00	63.000 -	7700.000	908.727	10.0000	11		
	Tetrachloroethene	UG/KG	1/ 32	5.00 -	5.00	1.400 -	1.400	1.400	12000.0000			
*	Thallium	MG/KG	6/ 32	0.25 -	1.00	0.073 -	2.900	1.177	0.6300	4	0.630	4
	Tin	MG/KG	3/ 32	1.10 -	11.20	32.800 -	81.000	50.800	4700.0000			

Table 6.2.3.12
AOC 684
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Toluene	UG/KG	25/ 32	5.00 -	16.80	1.900 -	143.000	14.180	1600000.0000			
Vanadium	MG/KG	31/ 32	3.30 -	3.30	7.900 -	72.000	34.156	55.0000	6	77.380	
Xylene (total)	UG/KG	14/ 32	5.00 -	5.00	1.400 -	9.300	3.357	16000000.0000			
Zinc	MG/KG	24/ 32	4.70 -	70.60	5.100 -	180.000	75.162	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- d Dibenz(a,h)anthracene used as surrogate
- e Acenaphthene used as surrogate
- f Fluoranthene used as surrogate
- g Endosulfan used as surrogate
- h Endrin used as surrogate
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate
- l gamma-BHC (Lindane) used as surrogate

Table 6.2.3.13
SWMU 14 (Includes SWMU 15, AOC 670 and AOC 684)
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Arsenic	UG/L	5/ 5			1.000 -	7.600	4.080	0.0380	5	27.990	
Barium	UG/L	2/ 5	30.10 -	38.40	84.300 -	166.000	125.150	260.0000		323.000	
* Dioxin (TCDD TEQ)	PG/L	5/ 5			2.038 -	11.368	4.848	0.5000	5		
1234678-HpCDD	PG/L	3/ 5	5.06 -	6.77	2.146 -	4.200	3.398				
1234678-HpCDF	PG/L	2/ 5	3.31 -	4.17	2.656 -	4.972	3.814				
123478-HxCDF	PG/L	1/ 5	1.19 -	2.24	1.863 -	1.863	1.863				
123789-HxCDF	PG/L	1/ 5	0.81 -	3.68	2.019 -	2.019	2.019				
123678-HxCDF	PG/L	3/ 5	1.10 -	5.20	1.369 -	2.169	1.766				
OCDD	PG/L	3/ 5	13.24 -	26.42	30.000 -	64.419	47.759				
12378-PeCDD	PG/L	3/ 5	3.21 -	7.28	1.684 -	3.249	2.493				
23478-PeCDF	PG/L	1/ 5	0.93 -	30.94	1.808 -	1.808	1.808				
12378-PeCDF	PG/L	1/ 5	0.93 -	2.07	11.023 -	11.023	11.023				
2378-TCDD	PG/L	2/ 5	0.99 -	2.28	1.936 -	8.800	5.368				
2378-TCDF	PG/L	1/ 5	1.67 -	3.29	8.105 -	8.105	8.105				
* bis(2-Ethylhexyl)phthalate	UG/L	5/ 5			1.800 -	11.800	5.320	4.8000	3		
Lead	UG/L	5/ 5			1.300 -	5.000	2.900	15.0000j		4.700	1
Selenium	UG/L	3/ 5	0.90 -	0.90	1.200 -	1.600	1.333	18.0000		3.150	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water

Table 6.2.3.14
SWMU 14 (Includes SWMU 15, AOC 670 and AOC 684)
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
* Aluminum	UG/L	3/ 5	18.50 - 110.00	462.000 - 15500.000	6354.000	3700.0000	1		
Barium	UG/L	3/ 5	28.80 - 32.90	44.200 - 58.400	52.966	260.0000		323.000	
Calcium	UG/L	5/ 5		74600.000 - 252000.000	183320.000				
* Chromium	UG/L	1/ 5	3.10 - 9.80	44.400 - 44.400	44.400	18.0000	1		
Iron	UG/L	5/ 5		2130.000 - 38400.000	16584.000				
* Lead	UG/L	1/ 5	1.90 - 3.60	19.700 - 19.700	19.700	15.0000j	1	4.700	1
Magnesium	UG/L	5/ 5		119000.000 - 190000.000	143600.000				
Manganese	UG/L	5/ 5		77.200 - 2350.000	1175.240	18.0000	5	3391.000	
Potassium	UG/L	5/ 5		38000.000 - 66000.000	51800.000				
Sodium	UG/L	5/ 5		596000.000 - 1270000.000	956200.000				
* Vanadium	UG/L	1/ 5	2.70 - 15.60	65.200 - 65.200	65.200	26.0000	1		
Zinc	UG/L	1/ 5	3.80 - 20.40	82.800 - 82.800	82.800	1100.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water

Table 6.2.3.15
SWMU 14 (Includes SWMU 15, AOC 670 and AOC 684)
Deep Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Arsenic	UG/L	5/ 5		1.200 - 10.200	3.800	0.0380	5	14.980	
* Barium	UG/L	4/ 5	57.50 - 57.50	89.100 - 268.000	152.525	260.0000	1	236.900	1
* Cadmium	UG/L	1/ 5	2.10 - 2.10	2.900 - 2.900	2.900	1.8000	1		
* Carbon disulfide	UG/L	4/ 5	5.00 - 5.00	1.200 - 3.500	2.050	2.1000	2		
* Chloroform	UG/L	1/ 5	5.00 - 5.00	2.000 - 2.000	2.000	0.1500	1		
2,4-D	UG/L	1/ 1		2.400 - 2.400	2.400	6.1000			
* Dioxin (TCDD TEQ)	PG/L	5/ 5		1.061 - 2.285	1.615	0.5000	5		
1234678-HpCDD	PG/L	3/ 5	3.03 - 3.83	2.191 - 7.181	4.195				
123678-HxCDF	PG/L	3/ 5	1.37 - 1.77	1.181 - 1.305	1.235				
123478-HxCDF	PG/L	2/ 5	1.24 - 1.82	1.486 - 2.133	1.809				
OCDD	PG/L	2/ 5	15.31 - 30.22	15.488 - 68.854	42.171				
OCDF	PG/L	2/ 5	11.36 - 17.90	3.792 - 5.897	4.844				
12378-PeCDD	PG/L	3/ 5	2.08 - 2.73	2.054 - 2.826	2.446				
23478-PeCDF	PG/L	1/ 5	3.83 - 8.40	1.370 - 1.370	1.370				
* bis(2-Ethylhexyl)phthalate	UG/L	2/ 5	10.00 - 11.20	1.700 - 7.500	4.600	4.8000	1		
* Heptachlor epoxide	UG/L	1/ 5	0.05 - 5.00	3.240 - 3.240	3.240	0.0012	1		
Isodrin	UG/L	2/ 5	0.10 - 10.00	8.000 - 11.300	9.650				
Lead	UG/L	3/ 5	1.10 - 1.10	1.300 - 8.300	3.766	15.0000j		4.260	1
Parathion	UG/L	1/ 5	1.00 - 1.00	1.000 - 1.000	1.000	22.0000			
Selenium	UG/L	4/ 5	0.90 - 0.90	1.100 - 1.700	1.350	18.0000		2.100	
2,4,5-T	UG/L	1/ 4	0.50 - 0.50	0.270 - 0.270	0.270	37.0000			
* Thallium	UG/L	2/ 5	1.00 - 2.00	1.200 - 1.200	1.200	0.2900	2		

Notes:
- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water

Table 6.2.3.16
SWMU 14 (Includes SWMU 15, AOC 670 and AOC 684)
Deep Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Arsenic	UG/L	1/ 5	2.70 - 4.50	5.500 - 5.500	5.500	0.0380	1	14.980	
Barium	UG/L	5/ 5		62.100 - 246.000	117.760	260.0000		236.900	1
* Cadmium	UG/L	3/ 5	1.20 - 1.20	1.800 - 2.900	2.233	1.8000	3		
Calcium	UG/L	5/ 5		169000.000 - 221000.000	190300.000				
Iron	UG/L	2/ 5	176.00 - 176.00	191.000 - 408.000	299.500				
Magnesium	UG/L	5/ 5		869000.000 - 1195000.000	1023000.000				
Manganese	UG/L	5/ 5		10.150 - 109.000	57.890	18.0000	4	776.200	
Potassium	UG/L	5/ 5		222000.000 - 284000.000	255700.000				
Sodium	UG/L	5/ 5		6740000.000 - 8025000.000	7693000.000				
2,4,5-T	UG/L	1/ 5	2.00 - 2.00	1.500 - 1.500	1.500	37.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.3.17
Exposure Pathways Summary — SWMU 14
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 14.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 14.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 14.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 14.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	CPSSs were greater than RBC and Reference concentrations.

Table 6.2.3.17
Exposure Pathways Summary — SWMU 14
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	No VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Deep groundwater, Ingestion of contaminants during potable or general use	Yes	CPSSs were greater than RBC and Reference concentrations.
	Deep groundwater, Inhalation of volatilized contaminants during domestic use	Yes	VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs for first quarter deep groundwater. No VOCs were identified as COPCs based on second quarter groundwater data.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.3.18
Statistical Analysis of COPCs
Surface Soils at SWMU 14
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Aluminum	3	NA	NA	NA	NA	29600	29600	MAX used	NA	29600
Arsenic	12	2.6969	0.2	1.843	16.9	13.6	13.6	MAX used	NA	14
Benzo(a)pyrene Equivalents	10	4.33	2.04	5.494	25.51	0.92521	0.93	MAX used	1	0.93
Beryllium	12	-0.0378	0.12	1.789	1.035	1.2	1.035	UCL used	NA	1.035
Chromium	12	4.1081	0.24	1.877	72	91	72	UCL used	NA	72
Lead	12	5.092	1.16	3.218	983	915	915	MAX used	NA	915
Manganese	3	NA	NA	NA	NA	473	473	MAX used	NA	473
Thallium	12	-1.6741	0.3389	1.966	0.24	0.55	0.24	UCL used	NA	0.24
Vanadium	12	4.1029	0.17	1.823	67.4	71.9	67.4	UCL used	NA	67.41

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
TEF toxic equivalency factor
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.3.19
Statistical Analysis of COPCs
Surface Soils at Combined AOC 670
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed SD	mean	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Antimony	29	1.16	1.07	2.658	10.231	11.4	10.231	UCL used	NA	10.231
Arsenic	29	0.47	2.41	1.918	14.743	69	14.743	UCL used	NA	14.743
Benzo(a)pyrene Equivalents	34	1.53	5.52	3.090	1.833	27.8828	1.833	UCL used	1	1.833
Lead	29	1.92	3.54	3.755	850.318	20900	850.318	UCL used	NA	850.318
Thallium	29	0.78	-0.88	2.202	0.778	1.4	0.778	UCL used	NA	0.778
Aluminum	20	0.50	9.30	2.002	15594.355	21700	15594	UCL used	NA	15594
Beryllium	29	0.31	-0.42	1.807	0.766	1.2	0.766	UCL used	NA	0.766
Chromium	29	0.18	3.94	1.739	55.444	74.2	55.444	UCL used	NA	55.444
Manganese	20	0.67	5.10	2.177	286.901	418	286.901	UCL used	NA	286.901
Nickel	29	0.21	2.97	1.753	21.362	29	21.362	UCL used	NA	21.362
Vanadium	29	0.34	3.70	1.827	48.192	68.3	48.192	UCL used	NA	48.192

NOTES:

mean	arithmetic mean of the logtransformed data
n	number of samples analyzed
SD	standard deviation for a sample of data
H-stat	"H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA	not applicable
EPC	exposure point concentration
UCL	95 percentile upper confidence level mean
MAX	maximum reported concentration

Table 6.2.3.20
Statistical Analysis of COPCs
Surface Soils at AOC 684
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Antimony	32	0.68	1.04	2.467	5.374	12.4	5.374	UCL used	NA	5.374
Aroclor-1254	39	3.39	0.9	2.268	0.062	0.16	0.062	UCL used	NA	0.062
Aroclor-1260	39	3.45	0.95	2.322	0.071	0.376	0.071	UCL used	NA	0.071
Arsenic	32	1.56	0.9	2.305	10.356	16.3	10.356	UCL used	NA	10.356
Benzo(a)pyrene Equivalents	44	5.75	1.82	3.380	4.207	29.871	4.207	UCL used	1	4.207
Beryllium	32	-0.89	0.91	2.316	0.907	1.51	0.907	UCL used	NA	0.907
7,12-Dimethylbenz(a)anthracene	32	5.42	0.68	2.080	0.367	1.73	0.367	UCL used	0.1	0.037
Thallium	32	-1.12	0.82	2.219	0.633	2.9	0.633	UCL used	NA	0.633
Vanadium	32	3.29	0.78	2.178	49.366	72	49.366	UCL used	NA	49.366

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
TEF toxic equivalency factor
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.3.21
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aluminum	NA	29600	4.05E-02	3.78E-01	4.63E-02	1.45E-02	5.17E-03
Arsenic	NA	14	1.86E-05	1.74E-04	2.13E-05	6.65E-06	2.38E-06
Benzo(a)pyrene Equivalents	1	0.93	1.27E-06	1.18E-05	1.45E-06	4.53E-07	1.62E-07
Beryllium	NA	1.035	1.42E-06	1.32E-05	1.62E-06	5.06E-07	1.81E-07
Chromium	NA	72	9.82E-05	9.17E-04	1.12E-04	3.51E-05	1.25E-05
Manganese	NA	915	1.25E-03	1.17E-02	1.43E-03	4.48E-04	1.60E-04
Lead	NA	915	1.25E-03	1.17E-02	1.43E-03	4.48E-04	1.60E-04
Thallium	NA	0.24	3.33E-07	3.10E-06	3.80E-07	1.19E-07	4.24E-08
Vanadium	NA	67.41	9.23E-05	8.62E-04	1.06E-04	3.30E-05	1.18E-05

NOTES:

TEF toxic equivalency factor relative to Benzo(a)pyrene for PAHs
lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 6.2.3.22
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aluminum	NA	29600	0.001	1.66E-03	5.49E-03	1.04E-03	1.19E-03	4.24E-04
Arsenic	NA	14	0.001	7.64E-07	2.52E-06	4.78E-07	5.46E-07	1.95E-07
Benzo(a)pyrene Equivalents	1	0.93	0.01	5.20E-07	1.72E-06	3.25E-07	3.71E-07	1.33E-07
Beryllium	NA	1.035	0.001	5.81E-08	1.92E-07	3.64E-08	4.15E-08	1.48E-08
Chromium	NA	72	0.001	4.03E-06	1.33E-05	2.52E-06	2.88E-06	1.03E-06
Manganese	NA	915	0.001	5.14E-05	1.70E-04	3.22E-05	3.67E-05	1.31E-05
Lead	NA	473	0.001	2.66E-05	8.77E-05	1.66E-05	1.90E-05	6.78E-06
Thallium	NA	0.24	0.001	1.36E-08	4.50E-08	8.53E-09	9.74E-09	3.48E-09
Vanadium	NA	67.41	0.001	3.79E-06	1.25E-05	2.37E-06	2.70E-06	9.66E-07

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene for PAHs
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.3.23
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 15
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Arsenic	NA	53	7.27E-05	6.79E-04	8.31E-05	2.60E-05	9.28E-06
Benzo(a)pyrene Equivalents	1	2.03	2.78E-06	2.59E-05	3.18E-06	9.92E-07	3.54E-07
Manganese	NA	506.00	6.93E-04	6.47E-03	7.92E-04	2.48E-04	8.84E-05

NOTES:

TEF	toxic equivalency factor relative to Benzo(a)pyrene for PAHs
lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk

Table 6.2.3.24
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 15
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Arsenic	NA	53	0.001	2.98E-06	9.84E-06	1.87E-06	2.13E-06	7.61E-07
Benzo(a)pyrene Equivalents	1	2.03	0.01	1.14E-06	3.76E-06	7.13E-07	8.14E-07	2.91E-07
Manganese	NA	506	0.001	2.84E-05	9.38E-05	1.78E-05	2.03E-05	7.25E-06

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene for PAHs
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.3.25
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 670
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	NA	10.231	1.40E-05	1.31E-04	1.60E-05	5.01E-06	1.79E-06
Arsenic	NA	14.743	2.02E-05	1.89E-04	2.31E-05	7.21E-06	2.58E-06
Benzo(a)pyrene Equivalents	1	1.833	2.51E-06	2.34E-05	2.87E-06	8.97E-07	3.20E-07
Lead	NA	850.318	1.16E-03	1.09E-02	1.33E-03	4.16E-04	1.49E-04
Thallium	NA	0.778	1.07E-06	9.95E-06	1.22E-06	3.81E-07	1.36E-07
Aluminum	NA	15594.355	2.14E-02	1.99E-01	2.44E-02	7.63E-03	2.72E-03
Beryllium	NA	0.766	1.05E-06	9.80E-06	1.20E-06	3.75E-07	1.34E-07
Chromium	NA	55.444	7.60E-05	7.09E-04	8.68E-05	2.71E-05	9.69E-06
Manganese	NA	286.901	3.93E-04	3.67E-03	4.49E-04	1.40E-04	5.01E-05
Nickel	NA	21.362	2.93E-05	2.73E-04	3.34E-05	1.05E-05	3.73E-06
Vanadium	NA	48.192	6.60E-05	6.16E-04	7.54E-05	2.36E-05	8.42E-06

NOTES:

lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- exposure point concentrations were adjusted to equivalent concentrations by their corresponding TEF

Table 6.2.3.26
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 670
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	NA	10.231	0.001	5.75E-07	1.90E-06	3.60E-07	4.10E-07	1.47E-07
Arsenic	NA	14.743	0.001	8.28E-07	2.73E-06	5.18E-07	5.91E-07	2.11E-07
Benzo(a)pyrene Equivalents	1	1.833	0.01	1.03E-06	3.40E-06	6.44E-07	7.35E-07	2.63E-07
Lead	NA	850.318	0.001	4.78E-05	1.58E-04	2.99E-05	3.41E-05	1.22E-05
Thallium	NA	0.778	0.001	4.37E-08	1.44E-07	2.73E-08	3.12E-08	1.11E-08
Aluminum	NA	15594.355	0.001	8.76E-04	2.89E-03	5.48E-04	6.26E-04	2.23E-04
Beryllium	NA	0.766	0.001	4.30E-08	1.42E-07	2.69E-08	3.07E-08	1.10E-08
Chromium	NA	55.444	0.001	3.11E-06	1.03E-05	1.95E-06	2.22E-06	7.94E-07
Manganese	NA	286.901	0.001	1.61E-05	5.32E-05	1.01E-05	1.15E-05	4.11E-06
Nickel	NA	21.362	0.001	1.20E-06	3.96E-06	7.51E-07	8.57E-07	3.06E-07
Vanadium	NA	48.192	0.001	2.71E-06	8.93E-06	1.69E-06	1.93E-06	6.90E-07

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.3.27
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 684
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	NA	5	7.36E-06	6.87E-05	8.41E-06	2.63E-06	9.39E-07
Aroclor-1254	NA	0.06	8.49E-08	7.92E-07	9.70E-08	3.03E-08	1.08E-08
Aroclor-1260	NA	0.071	9.69E-08	9.05E-07	1.11E-07	3.46E-08	1.24E-08
Arsenic	NA	10.356	1.42E-05	1.32E-04	1.62E-05	5.07E-06	1.81E-06
Benzo(a)pyrene Equivalents	1	4	5.76E-06	5.38E-05	6.59E-06	2.06E-06	7.35E-07
Beryllium	NA	0.91	1.24E-06	1.16E-05	1.42E-06	4.44E-07	1.59E-07
7,12-Dimethylbenz(a)anthracene	0.1	0.04	5.03E-08	4.69E-07	5.74E-08	1.80E-08	6.41E-09
Thallium	NA	0.633	8.67E-07	8.10E-06	9.91E-07	3.10E-07	1.11E-07
Vanadium	NA	49.366	6.76E-05	6.31E-04	7.73E-05	2.42E-05	8.63E-06

NOTES:

TEF toxic equivalency factor relative to Benzo(a)pyrene for PAHs
lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.3.28
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 684
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	NA	5.374	0.001	3.02E-07	9.96E-07	1.89E-07	2.16E-07	7.70E-08
Aroclor-1254	NA	0.062	0.01	3.48E-08	1.15E-07	2.18E-08	2.48E-08	8.87E-09
Aroclor-1260	NA	0.071	0.01	3.97E-08	1.31E-07	2.49E-08	2.84E-08	1.01E-08
Arsenic	NA	10.356	0.001	5.82E-07	1.92E-06	3.64E-07	4.15E-07	1.48E-07
Benzo(a)pyrene Equivalents	1	4.207	0.01	2.36E-06	7.80E-06	1.48E-06	1.69E-06	6.03E-07
Beryllium	NA	0.907	0.001	5.10E-08	1.68E-07	3.19E-08	3.64E-08	1.30E-08
7,12-Dimethylbenz(a)anthracene	0.1	0.037	0.01	2.06E-08	6.80E-08	1.29E-08	1.47E-08	5.26E-09
Thallium	NA	0.633	0.001	3.56E-08	1.17E-07	2.23E-08	2.54E-08	9.07E-09
Vanadium	NA	49.366	0.001	2.77E-06	9.15E-06	1.74E-06	1.98E-06	7.07E-07

NOTES:

TEF Toxic Equivelency Factor relative to Benzo(a)pyrene for PAHs
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
- exposure point concentrations for PNAs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.3.29
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
Combined SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Dioxin (TCDD TEQ)	0.00000	3.11E-10	7.27E-10	1.71E-10	1.16E-10	4.13E-11
bis(2-Ethylhexyl)phthalate	0.0118	3.23E-04	7.54E-04	1.78E-04	1.20E-04	4.29E-05
Aluminum	15.5	4.25E-01	9.91E-01	2.34E-01	1.58E-01	5.63E-02
Chromium (trivalent)	0.0444	1.22E-03	2.84E-03	6.69E-04	4.52E-04	1.61E-04
Lead	0.0197	5.40E-04	1.26E-03	2.97E-04	2.00E-04	7.16E-05
Vanadium	0.0652	1.79E-03	4.17E-03	9.82E-04	6.63E-04	2.37E-04

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.3.30
Chronic Daily Intakes (CDI)
Ingestion of Deep Groundwater
Combined SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Barium	0.268	7.34E-03	1.71E-02	4.04E-03	2.73E-03	9.74E-04
Cadmium	0.0029	7.95E-05	1.85E-04	4.37E-05	2.95E-05	1.05E-05
Carbon disulfide	0.0035	9.59E-05	2.24E-04	5.27E-05	3.56E-05	1.27E-05
Chloroform	0.002	5.48E-05	1.28E-04	3.01E-05	2.04E-05	7.27E-06
Dioxin (TCDD TEQ)	2.29E-08	6.26E-10	1.46E-09	3.44E-10	2.33E-10	8.30E-11
bis(2-Ethylhexyl)phthalate	0.0075	2.05E-04	4.79E-04	1.13E-04	7.63E-05	2.73E-05
Heptachlor epoxide	0.00324	8.88E-05	2.07E-04	4.88E-05	3.30E-05	1.18E-05
Thallium	0.0012	3.29E-05	7.67E-05	1.81E-05	1.22E-05	4.36E-06

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

le 6.2.3.31 - SWMU 14
icological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

emical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)	Confidence Level	Critical Effect
minum	1	e			ND	ND		
imony	0.0004	a	L	whole body/blood increased mortality	1000	ND		
enic	0.0003	a	M	hyperpigmentation	3	ND		
nzo(a)pyrene Equivalents	ND				ND	ND		
yllium	0.005	a	L	microscopic organ changes	100	ND		
(2-Ethylhexyl)phthalate	0.02	a	M	increased liver weight	1000	ND		
dmium (food)	0.001	a	H	proteinuria	10	ND		
dmium (water)	0.0005	a	H	proteinuria	10	ND		
,7,8-TCDD	ND				ND	ND		
allium	8E-05	a		increased SGOT (liver) increased serum LDH	3000	ND		
nadium	0.007	a		unclear	100	ND		
otachlor epoxide	0.000013	a	L	liver weight increase	1000	ND		
oroform	0.01	a	M/L	fatty cysts in liver	1000	ND		

NOTES:

a Integrated Risk Information System (IRIS)
b Health Effects Assessment Summary Tables (HEAST)
e EPA Environmental Criteria and Assessment Office - Cincinnati (provisional)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

ıble 6.2.3.31 - SWMU 14
ɔxicological Database Information
· Chemicals of Potential Concern
ɅVBASE Charleston, Zone H

Carcinogenic Toxicity Data

ıemical	Uncertainty Factor Inhalation	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
uminum	ND	ND		ND		ND	
ıtimony	ND	ND		ND		D	
senic	ND	1.5	a	15.1	a	A	various
›nzo(a)pyrene Equivalents	ND	7.3	a	3.1	g	B2	mutagen
›ryllium	ND	4.3	a	8.4	a	B2	osteosarcoma
;(2-Ethylhexyl)phthalate	ND	0.014	a	ND		B2	hepatoma
ıdmium (food)	ND	ND		6.3	a	B1	lung
ıdmium (water)	ND	ND		6.3	a	B1	lung
3,7,8-TCDD	ND	150000	b			B2	mutagen and teratogen
ıallium	ND	ND		ND		D	
ınadium	ND	ND		ND		D	
›ptachlor epoxide	ND	9.1	a	ND		B2	liver carcinoma
ıloroform	ND	0.0061	a	2.3E-05 ((ug/c	a	B2	

Table 6.2.3.32
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aluminum	1	NA	0.04	0.38	ND	0.01	ND
Arsenic	0.0003	1.5	0.06	0.58	3.2E-05	0.02	3.6E-06
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	1.1E-05	ND	1.2E-06
Beryllium	0.005	4.3	0.0003	0.003	7.0E-06	0.0001	7.8E-07
Chromium	1	NA	0.0001	0.0009	ND	0.00004	ND
Manganese	0.14	NA	0.009	0.08	ND	0.0032	ND
Lead	NA	NA	ND	ND	ND	ND	ND
Thallium	8E-05	NA	0.004	0.04	ND	0.001	ND
Vanadium	0.007	NA	0.01	0.12	ND	0.005	ND
SUM Hazard Index/ILCR			0.13	1	5E-05	0.05	6E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.3.33
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aluminum	0.2	0.2	NA	0.008	0.03	ND	0.006	ND
Arsenic	0.2	6E-05	7.5	0.01	0.04	3.6E-06	0.009	1.5E-06
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	4.7E-06	ND	1.9E-06
Beryllium	0.2	0.001	21.5	0.0001	0.0002	7.8E-07	0.00004	3.2E-07
Chromium	0.2	0.2	NA	0.00002	0.0001	ND	0.00001	ND
Manganese	0.2	0.028	NA	ND	ND	ND	ND	
Lead	0.5	NA	NA	ND	ND	ND	ND	ND
Thallium	0.2	1.6E-05	NA	0.0009	0.003	ND	0.0006	ND
Vanadium	0.2	0.0014	NA	0.003	0.009	ND	0.002	ND
SUM Hazard Index/ILCR				0.02	0.08	9E-06	0.02	4E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.3.34
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 15
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Arsenic	0.0003	1.5	0.24	2.3	1.2E-04	0.09	1.4E-05
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.3E-05	ND	2.6E-06
Manganese	0.14	NA	0.005	0.05	ND	0.002	ND
SUM Hazard Index/ILCR			0.2	2	1E-04	0.09	2E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.3.35
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 15
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Arsenic	0.2	6E-05	7.5	0.05	0.16	1.4E-05	0.04	5.7E-06
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.0E-05	ND	4.2E-06
Manganese	0.2	0.028	NA	0.001	0.003	ND	0.0007	ND
SUM Hazard Index/ILCR				0.05	0.2	2E-05	0.04	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.3.36
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 670
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.0004	NA	0.04	0.3	ND	0.01	ND
Arsenic	0.0003	1.5	0.07	0.6	3.5E-05	0.02	3.9E-06
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.1E-05	ND	2.3E-06
Lead *	NA	NA	ND	ND	ND	ND	ND
Thallium	8E-05	NA	0.01	0.1	ND	0.005	ND
Aluminum	1	NA	0.02	0.2	ND	0.008	ND
Beryllium	0.0054	NA	0.0002	0.002	ND	0.0001	ND
Chromium	1	NA	0.0001	0.001	ND	0.00003	ND
Manganese	0.14	NA	0.003	0.03	ND	0.001	ND
Nickel	0.02	NA	0.001	0.01	ND	0.001	ND
Vanadium	0.007	NA	0.01	0.09	ND	0.003	ND
SUM Hazard Index/ILCR			0.2	1	6E-05	0.05	6E-06

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk
*	see Lead Uptake/Biokinetic Model output

Table 6.2.3.37
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 670
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.2	8E-05	NA	0.007	0.02	ND	0.005	ND
Arsenic	0.2	6E-05	7.5	0.01	0.05	3.9E-06	0.01	1.6E-06
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	9.4E-06	ND	3.8E-06
Lead*	0.2	NA	NA	ND	ND	ND	ND	ND
Thallium	0.2	1.6E-05	NA	0.003	0.009	ND	0.002	ND
Aluminum	0.2	0.2	NA	0.004	0.01	ND	0.003	ND
Beryllium	0.2	0.00108	NA	0.00004	0.0001	ND	0.00003	ND
Chromium	0.2	0.2	NA	0.00002	0.0001	ND	0.00001	ND
Manganese	0.2	0.028	NA	0.001	0.002	ND	0.0004	ND
Nickel	0.2	0.004	NA	0.0003	0.001	ND	0.0002	ND
Vanadium	0.2	0.0014	NA	0.002	0.006	ND	0.001	ND
SUM Hazard Index/ILCR				0.03	0.1	1E-05	0.02	5E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)
* see Lead Uptake/Biokinetic Model output

Table 6.2.3.38
NAVBASE — Charleston Zone H
APC 670
USEPA LEAD MODEL Version 0.99d Output

AIR CONCENTRATION: 0.100 μg Pb/m³ DEFAULT

Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m^3/day)	Lung Abs. (%)
5-6	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 15.00 μg Pb/L
(set equal to the USEPA Office of Water Treatment Technique AL)
WATER Consumption: Default

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (μg Pb/g)	House Dust (μg Pb/g)
5-6	200.0	200.0

Additional Dust Sources: None DEFAULT

ALTERNATE SOURCE Intake:
5-6: 0.50 μg Pb/day

CALCULATED BLOOD Pb and Pb UPTAKES:

Year	Blood Level (μg/dL)	Total Uptake (μg/day)	Soil + Dust (μg/day)
5-6	3.9	12.65	5.08

Year	Diet Uptake (μg/day)	Water Uptake (μg/day)	Alternate Source Uptake (μg/day)	Air Uptake (μg/day)
5-6	2.98	4.09	0.41	0.09

Table 6.2.3.39
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 684
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.0004	NA	0.02	0.2	ND	0.007	ND
Aroclor-1254	2E-05	7.7	0.004	0.04	7.5E-07	0.002	8.3E-08
Aroclor-1260	NA	7.7	ND	ND	8.5E-07	ND	9.5E-08
Arsenic	0.0003	1.5	0.05	0.4	2.4E-05	0.02	2.7E-06
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	4.8E-05	ND	5.4E-06
Beryllium	0.005	4.3	0.0002	0.002	6.1E-06	0.0001	6.8E-07
7,12-Dimethylbenz(a)anthracene	NA	7.3	ND	ND	4.2E-07	ND	4.7E-08
Thallium	8E-05	NA	0.01	0.1	ND	0.004	ND
Vanadium	0.007	NA	0.01	0.09	ND	0.003	ND
SUM Hazard Index/ILCR			0.09	1	8E-05	0.03	9E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.3.40
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 684
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.2	8E-05	NA	0.004	0.01	ND	0.003	ND
Aroclor-1254	0.5	1E-05	15.4	0.003	0.01	3.4E-07	0.002	1.4E-07
Aroclor-1260	0.5	NA	15.4	ND	ND	3.8E-07	ND	1.6E-07
Arsenic	0.2	6E-05	7.5	0.01	0.03	2.7E-06	0.007	1.1E-06
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	2.2E-05	ND	8.8E-06
Beryllium	0.2	0.001	21.5	0.0001	0.0002	6.9E-07	0.00004	2.8E-07
7,12-Dimethylbenz(a)anthracene	0.5	NA	14.6	ND	ND	1.9E-07	ND	7.7E-08
Thallium	0.2	1.6E-05	NA	0.002	0.007	ND	0.002	ND
Vanadium	0.2	0.0014	NA	0.002	0.007	ND	0.001	ND
SUM Hazard Index/ILCR				0.02	0.07	3E-05	0.02	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.3.41
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
Combined SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Dioxin (TCDD TEQ)	NA	150000	ND	ND	2.6E-05	ND	6.2E-06
bis(2-Ethylhexyl)phthalate	0.02	0.014	0.02	0.04	2.5E-06	0.006	6.0E-07
Aluminum	1	NA	0.4	1.0	ND	0.2	ND
Chromium (trivalent)	1	NA	0.001	0.003	ND	0.0005	ND
Lead	NA	NA	ND	ND	ND	ND	ND
Vanadium	0.007	NA	0.3	0.6	ND	0.09	NS
SUM Hazard Index/ILCR			0.7	2	2.8E-05	0.3	6.8E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.3.42
Hazard Quotients and Incremental Lifetime Cancer Risks
Deep Groundwater Ingestion
Combined SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Barium	0.000143	NA	ND	ND	ND	ND	ND
Cadmium	0.0005	NA	0.2	0.4	ND	0.06	ND
Carbon disulfide	0.1	NA	0.001	0.002	ND	0.0004	ND
Chloroform	0.01	0.0061	0.005	0.01	1.8E-07	0.002	4.4E-08
Dioxin (TCDD TEQ)	NA	150000	ND	ND	5.2E-05	ND	1.2E-05
bis(2-Ethylhexyl)phthalate	0.02	0.014	0.01	0.024	1.6E-06	0.004	3.8E-07
Heptachlor epoxide	1.3E-05	9.1	7	16	4.4E-04	3	1.1E-04
Thallium	8E-05	NA	0.4	1	ND	0.2	ND
SUM Hazard Index/ILCR			7	17	5.0E-04	3	1.2E-04

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.3.43
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Deep Groundwater
Combined SWMU 14
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Carbon disulfide	0.00286	NA	0.03	0.08	ND	0.01	ND
Chloroform	NA	0.0805	ND	ND	2.4E-06	ND	5.9E-07
SUM Hazard Index/ILCR			0.03	0.1	2.4E-06	0.01	5.9E-07

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk

Table 6.2.3.44
Summary of Risk and Hazard-based COCs for Combined SWMU 14
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs			
Surface Soil											
SWMU 14	Incidental	Aluminum	0.04	0.38	ND	0.01	ND	1			
	Ingestion	Arsenic	0.06	0.58	3.2E-05	0.02	3.6E-06	1	2		4
		Benzo(a)pyrene Equiv.	ND	ND	1.1E-05	ND	1.2E-06		2		4
		Beryllium	0.0003	0.003	7E-08	0.0001	7.8E-07		2		
		Vanadium	0.01	0.12	ND	0.005	ND	1			
	Dermal	Arsenic	0.01	0.04	3.6E-06	0.009	1.5E-06		2		4
	Contact	Benzo(a)pyrene Equiv.	ND	ND	4.7E-06	ND	1.9E-06		2		4
Surface Soil Pathway Sum for SWMU 14			0.1	1	6E-05	0.04	9E-06				
SWMU 15	Incidental	Arsenic	0.24	2.3	1.2E-04	0.09	1.4E-05	1	2		4
	Ingestion	Benzo(a)pyrene Equiv.	ND	ND	2.3E-05	ND	2.6E-06		2		4
	Dermal	Arsenic	0.05	0.16	1.4E-05	0.04	5.7E-06	1	2		4
	Contact	Benzo(a)pyrene Equiv.	ND	ND	1.0E-05	ND	4.2E-06		2		4
Surface Soil Pathway Sum for SWMU 15			0.3	2	2E-04	0.1	3E-05				
AOC 670	Incidental	Aluminum	0.02	0.2	ND	0.008	ND	1			
	Ingestion	Antimony	0.04	0.3	ND	0.01	ND	1			
		Arsenic	0.07	0.6	3.5E-05	0.02	3.9E-06	1	2		4
		Benzo(a)pyrene Equiv.	ND	ND	2.1E-05	ND	2.3E-06		2		4
		Thallium	0.01	0.1	ND	0.006	ND				
	Dermal	Arsenic	0.01	0.05	3.9E-06	0.01	1.6E-06		2		4
	Contact	Benzo(a)pyrene Equiv.	ND	ND	9.4E-06	ND	3.8E-06		2		4
Surface Soil Pathway Sum for AOC 670			0.2	1	7E-05	0.1	1E-05				
AOC 684	Incidental	Antimony	0.02	0.2	ND	0.007	ND	1			
	Ingestion	Arsenic	0.05	0.4	2.4E-05	0.02	2.7E-06	1	2		4
		Benzo(a)pyrene Equiv.	ND	ND	4.8E-05	ND	5.4E-06		2		4
		Beryllium	0.0002	0.002	6.1E-06	0.0001	6.8E-07		2		
		Thallium	0.01	0.1	ND	0.004	ND				
	Dermal	Arsenic	0.01	0.03	2.7E-06	0.007	1.1E-06		2		4
	Contact	Benzo(a)pyrene Equiv.	ND	ND	2.2E-05	ND	8.8E-06		2		4
Surface Soil Pathway Sum for AOC 684			0.1	1	1E-04	0.04	2E-05				
Shallow Groundwater	Ingestion	Aluminum	0.4	1	ND	0.2	ND	1		3	
		bis(2-Ethylhexyl)phthal	0.02	0.04	2.5E-06	0.006	6.0E-07		2		
		Dioxin (TCDD TEQ)	ND	ND	2.6E-05	ND	6.2E-06		2		4
		Vanadium	0.3	0.6	ND	0.09	ND	1			
Shallow Groundwater Pathway Sum			0.7	2	3E-05	0.3	7E-06				
Deep Groundwater	Ingestion	Cadmium	0.2	0.4	ND	0.06	ND	1			
		Dioxin (TCDD TEQ)	ND	ND	5.2E-05	ND	1.2E-05		2		4
		bis(2-Ethylhexyl)phthal	0.01	0.024	1.6E-06	0.004	3.8E-07		2		
		Heptachlor epoxide	7	16	4.4E-04	3	1.1E-04	1		3	
		Thallium	0.4	1	ND	0.2	ND	1		3	
	Inhalation	Chloroform	ND	ND	2.4E-06	ND	5.9E-07		2		
Deep Groundwater Pathway Sum			8	17	5E-04	3	1E-04				
Combined Media Summaries											
Sum of SWMU 14 Soil/Shallow Groundwater Pathways			1	3	9E-05	0.3	2E-05				
Sum of SWMU 14 Soil/Deep Groundwater Pathways			8	19	6E-04	3	1E-04				
Sum of SWMU 15 Soil/Shallow Groundwater Pathways			1	4	2E-04	0.4	3E-05				
Sum of SWMU 15 Soil/Deep Groundwater Pathways			8	20	7E-04	3	1E-04				
Sum of AOC 670 Soil/Shallow Groundwater Pathways			1	3	1E-04	0.3	2E-05				
Sum of AOC 670 Soil/Deep Groundwater Pathways			8	19	6E-04	3	1E-04				
Sum of AOC 684 Soil/Shallow Groundwater Pathways			1	2	1E-04	0.3	3E-05				
Sum of AOC 684 Soil/Deep Groundwater Pathways			8	18	6E-04	3	1E-04				

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.
Benzo(a)pyrene equivalents were identified as COCs for surface soil based on combined ingestion and dermal contact pathway risk.

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
014SB001	SS	Chromium	39.2		MG/KG	0.003	
014SB002	SS	Chromium	59.7		MG/KG	0.004	
014SB003	SS	Chromium	91.0		MG/KG	0.01	
014SB004	SS	Arsenic	11.9		MG/KG	0.54	3.1E-05
014SB004	SS	Beryllium	0.88		MG/KG	0.002	6.6E-06
014SB004	SS	Chromium	52.4		MG/KG	0.004	
014SB005	SS	Chromium	62.1		MG/KG	0.004	
014SB005	SS	Benzo(a)pyrene Equivalents	6.30		UG/KG		1.0E-07
014SB006	SS	Beryllium	1.00		MG/KG	0.003	7.5E-06
014SB006	SS	Chromium	69.6		MG/KG	0.005	
014SB007	SS	Beryllium	1.00		MG/KG	0.003	7.5E-06
014SB007	SS	Chromium	67.9		MG/KG	0.005	
014SB007	SS	Benzo(a)pyrene Equivalents	76.0		UG/KG		1.3E-06
014SB008	SS	Beryllium	0.82		MG/KG	0.002	6.1E-06
014SB008	SS	Chromium	38.3		MG/KG	0.003	

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
014SB009	SS	Beryllium	1.00		MG/KG	0.003	7.5E-06
014SB009	SS	Chromium	64.2		MG/KG	0.004	
014SB010	SS	Aluminum	29600.0		MG/KG	0.41	
014SB010	SS	Beryllium	1.20		MG/KG	0.003	9.0E-06
014SB010	SS	Chromium	59.8		MG/KG	0.004	
014SB011	SS	Aluminum	14800.0		MG/KG	0.20	
014SB011	SS	Thallium	0.55	J	MG/KG	0.09	
014SB011	SS	Beryllium	0.82	J	MG/KG	0.002	6.1E-06
014SB011	SS	Chromium	65.0		MG/KG	0.004	
014SB106	SS	Aluminum	24600.0		MG/KG	0.34	
014SB106	SS	Arsenic	13.6		MG/KG	0.62	3.6E-05
014SB106	SS	Beryllium	1.1	J	MG/KG	0.003	8.2E-06
014SB106	SS	Chromium	82.0		MG/KG	0.01	
014SB106	SS	Benzo(a)pyrene Equivalents	925.2		UG/KG		1.5E-05
015SB001	SS	Arsenic	6.4		MG/KG	0.29	1.7E-05
015SB001	SS	Benzo(a)pyrene Equivalents	108.3		UG/KG		1.8E-06
015SB002	SS	Arsenic	3.6	J	MG/KG	0.16	9.4E-06

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
015SB003	SS	Arsenic	15.0		MG/KG	0.69	3.9E-05
015SB003	SS	Benzo(a)pyrene Equivalents	402.8		UG/KG		6.7E-06
015SB004	SS	Arsenic	53.1		MG/KG	2.43	1.4E-04
015SB004	SS	Benzo(a)pyrene Equivalents	2028.4		UG/KG		3.4E-05
015SB005	SS	Benzo(a)pyrene Equivalents	246.4		UG/KG		4.1E-06
015SB006	SS	Benzo(a)pyrene Equivalents	405.3		UG/KG		6.7E-06
015SB007	SS	Benzo(a)pyrene Equivalents	106.9		UG/KG		1.8E-06
670SB001	SS	Arsenic	15.6		MG/KG	0.71	4.1E-05
670SB002	SS	Arsenic	9.7		MG/KG	0.44	2.5E-05
670SB002	SS	Benzo(a)pyrene Equivalents	309.2		UG/KG		5.1E-06
670SB003	SS	Benzo(a)pyrene Equivalents	4880.7		UG/KG		8.1E-05
670SB004	SS	Arsenic	11.3		MG/KG	0.52	3.0E-05
670SB004	SS	Benzo(a)pyrene Equivalents	1020.7		UG/KG		1.7E-05

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
670SB005	SS	Arsenic	15.2		MG/KG	0.69	4.0E-05
670SB005	SS	Benzo(a)pyrene Equivalents	1590.9		UG/KG		2.6E-05
670SB006	SS	Arsenic	13.8		MG/KG	0.63	3.6E-05
670SB007	SS	Thallium	0.48		MG/KG	0.08	
670SB007	SS	Arsenic	8.90		MG/KG	0.41	2.3E-05
670SB008	SS	Arsenic	9.70		MG/KG	0.44	2.5E-05
670SB008	SS	Benzo(a)pyrene Equivalents	955.6		UG/KG		1.6E-05
670SB009	SS	Antimony	9.50	J	MG/KG	0.33	
670SB009	SS	Arsenic	9.10		MG/KG	0.42	2.4E-05
670SB010	SS	Thallium	0.82	J	MG/KG	0.14	
670SB010	SS	Arsenic	10.40		MG/KG	0.48	2.7E-05
670SB011	SS	Arsenic	8.90		MG/KG	0.41	2.3E-05
670SB012	SS	Antimony	11.40	J	MG/KG	0.39	
670SB012	SS	Arsenic	23.70		MG/KG	1.08	6.2E-05
670SB012	SS	Benzo(a)pyrene Equivalents	704.82		UG/KG		1.2E-05

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
670SB013	SS	Arsenic	10.90		MG/KG	0.50	2.8E-05
670SB013	SS	Benzo(a)pyrene Equivalents	58.7		UG/KG		9.7E-07
670SB014	SS	Arsenic	9.50		MG/KG	0.43	2.5E-05
670SB014	SS	Benzo(a)pyrene Equivalents	0.17		UG/KG		2.8E-09
670SB015	SS	Arsenic	9.70		MG/KG	0.44	2.5E-05
670SB015	SS	Benzo(a)pyrene Equivalents	101.72		UG/KG		1.7E-06
670SB016	SS	Arsenic	12.10	J	MG/KG	0.55	3.2E-05
670SB016	SS	Benzo(a)pyrene Equivalents	205.2		UG/KG		3.4E-06
670SB017	SS	Arsenic	8.20	J	MG/KG	0.37	2.1E-05
670SB018	SS	Arsenic	10.10	J	MG/KG	0.46	2.6E-05
670SB019	SS	Arsenic	7.00	J	MG/KG	0.32	1.8E-05
670SB019	SS	Benzo(a)pyrene Equivalents	80.43		UG/KG		1.3E-06
670SB020	SS	Arsenic	8.40		MG/KG	0.38	2.2E-05
670SB021	SS	Arsenic	7.90	J	MG/KG	0.36	2.1E-05

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
670SB022	SS	Arsenic	9.30	J	MG/KG	0.43	2.4E-05
670SB023	SS	Thallium	1.40		MG/KG	0.24	
670SB023	SS	Arsenic	69.0		MG/KG	3.15	1.8E-04
670SB024	SS	Arsenic	13.0	J	MG/KG	0.59	3.4E-05
670SB026	SS	Arsenic	12.3	J	MG/KG	0.56	3.2E-05
670SB027	SS	Arsenic	8.30	J	MG/KG	0.38	2.2E-05
670SB029	SS	Benzo(a)pyrene Equivalents	7525.1		UG/KG		1.2E-04
670SB030	SS	Benzo(a)pyrene Equivalents	165.3		UG/KG		2.7E-06
670SB031	SS	Arsenic	15.4		MG/KG	0.70	4.0E-05
670SB031	SS	Benzo(a)pyrene Equivalents	27882.8		UG/KG		4.6E-04
670SB032	SS	Arsenic	17.2		MG/KG	0.79	4.5E-05
670SB032	SS	Benzo(a)pyrene Equivalents	870.2		UG/KG		1.4E-05
670SB034	SS	Benzo(a)pyrene Equivalents	2136.3		UG/KG		3.5E-05

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
684SB002	SS	Arsenic	7.00	J	MG/KG	0.32	1.8E-05
684SB002	SS	Beryllium	0.32	J	MG/KG	0.001	2.4E-06
684SB003	SS	Arsenic	8.50		MG/KG	0.39	2.2E-05
684SB003	SS	Beryllium	0.62	J	MG/KG	0.002	4.6E-06
684SB003	SS	Benzo(a)pyrene Equivalents	8567.0		UG/KG		1.4E-04
684SB004	SS	Arsenic	12.7		MG/KG	0.58	3.3E-05
684SB004	SS	Beryllium	0.90		MG/KG	0.002	6.7E-06
684SB004	SS	Benzo(a)pyrene Equivalents	4361.0		UG/KG		7.2E-05
684SB005	SS	Arsenic	7.40		MG/KG	0.34	1.9E-05
684SB005	SS	Beryllium	0.53		MG/KG	0.001	4.0E-06
684SB005	SS	Benzo(a)pyrene Equivalents	75.02		UG/KG		1.2E-06
684SB007	SS	Aroclor-1260	376.0		UG/KG		6.6E-06
684SB007	SS	Arsenic	9.0		MG/KG	0.41	2.4E-05
684SB007	SS	Beryllium	0.67		MG/KG	0.002	5.0E-06
684SB008	SS	Thallium	0.091	J	MG/KG	0.02	
684SB008	SS	Arsenic	1.90		MG/KG	0.09	5.0E-06
684SB008	SS	Beryllium	0.28	J	MG/KG	0.001	2.1E-06

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
684SB009	SS	Thallium	2.90	J	MG/KG	0.50	
684SB009	SS	Antimony	5.60	J	MG/KG	0.19	
684SB009	SS	Arsenic	12.90		MG/KG	0.59	3.4E-05
684SB009	SS	Beryllium	1.51		MG/KG	0.004	1.1E-05
684SB010	SS	Thallium	0.073	J	MG/KG	0.01	
684SB010	SS	Arsenic	5.20		MG/KG	0.24	1.4E-05
684SB010	SS	Beryllium	0.40	J	MG/KG	0.001	3.0E-06
684SB011	SS	Arsenic	1.40		MG/KG	0.06	3.7E-06
684SB011	SS	Beryllium	0.13	J	MG/KG	0.0004	9.7E-07
684SB012	SS	Antimony	6.20	J	MG/KG	0.21	
684SB012	SS	Arsenic	0.89	J	MG/KG	0.04	2.3E-06
684SB012	SS	Beryllium	0.15	J	MG/KG	0.0004	1.1E-06
684SB013	SS	Antimony	4.60	J	MG/KG	0.16	
684SB013	SS	Arsenic	2.80		MG/KG	0.13	7.3E-06
684SB013	SS	Beryllium	0.19	J	MG/KG	0.0005	1.4E-06
684SB014	SS	Thallium	1.20	J	MG/KG	0.21	
684SB014	SS	Antimony	12.40		MG/KG	0.43	
684SB014	SS	Arsenic	11.70		MG/KG	0.53	3.1E-05

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
684SB014	SS	Beryllium	1.23		MG/KG	0.003	9.2E-06
684SB015	SS	Thallium	1.30	J	MG/KG	0.22	
684SB015	SS	Antimony	11.90		MG/KG	0.41	
684SB015	SS	Arsenic	13.50		MG/KG	0.62	3.5E-05
684SB015	SS	Beryllium	1.3		MG/KG	0.004	9.7E-06
684SB015	SS	Benzo(a)pyrene Equivalents	1515.5		UG/KG		2.5E-05
684SB016	SS	Thallium	1.50	J	MG/KG	0.26	
684SB016	SS	Antimony	5.30	J	MG/KG	0.18	
684SB016	SS	Arsenic	4.80		MG/KG	0.22	1.3E-05
684SB016	SS	Beryllium	0.49	J	MG/KG	0.001	3.7E-06
684SB017	SS	Antimony	7.70		MG/KG	0.26	
684SB017	SS	Arsenic	3.60		MG/KG	0.16	9.4E-06
684SB017	SS	Beryllium	0.37	J	MG/KG	0.001	2.8E-06
684SB017	SS	Benzo(a)pyrene Equivalents	120.3		UG/KG		2.0E-06
684SB018	SS	Antimony	10.1		MG/KG	0.35	
684SB018	SS	Arsenic	6.4		MG/KG	0.29	1.7E-05
684SB018	SS	Beryllium	0.48	J	MG/KG	0.001	3.6E-06
684SB018	SS	Benzo(a)pyrene Equivalents	122.7		UG/KG		2.0E-06

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
684SB019	SS	Beryllium	0.41		MG/KG	0.001	3.1E-06
684SB019	SS	Benzo(a)pyrene Equivalents	194.8		UG/KG		3.2E-06
684SB020	SS	Beryllium	0.87		MG/KG	0.002	6.5E-06
684SB020	SS	Benzo(a)pyrene Equivalents	2153.5		UG/KG		3.6E-05
684SB021	SS	Benzo(a)pyrene Equivalents	25501.3		UG/KG		4.2E-04
684SB022	SS	Beryllium	0.54		MG/KG	0.001	4.0E-06
684SB022	SS	Benzo(a)pyrene Equivalents	395.1		UG/KG		6.6E-06
684SB023	SS	Beryllium	0.48		MG/KG	0.001	3.6E-06
684SB023	SS	Benzo(a)pyrene Equivalents	1194.7		UG/KG		2.0E-05
684SB024	SS	Beryllium	1.20		MG/KG	0.003	9.0E-06
684SB024	SS	Benzo(a)pyrene Equivalents	4228.4		UG/KG		7.0E-05
684SB025	SS	Beryllium	0.69		MG/KG	0.002	5.2E-06
684SB025	SS	Benzo(a)pyrene Equivalents	287.2		UG/KG		4.8E-06
684SB026	SS	7,12-Dimethybenz(a)anthracene	1730.0	J	UG/KG		2.9E-05
684SB026	SS	Arsenic	16.3	J	MG/KG	0.75	4.3E-05
684SB026	SS	Beryllium	0.99		MG/KG	0.003	7.4E-06

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
684SB026	SS	Benzo(a)pyrene Equivalents	1922.4		UG/KG		3.2E-05
684SB027	SS	Arsenic	9.90	J	MG/KG	0.45	2.6E-05
684SB027	SS	Beryllium	0.61		MG/KG	0.002	4.6E-06
684SB027	SS	Benzo(a)pyrene Equivalents	502.5		UG/KG		8.3E-06
684SB028	SS	Benzo(a)pyrene Equivalents	232.1		UG/KG		3.9E-06
684SB032	SS	Aroclor-1260	60.0		UG/KG		1.1E-06
684SB032	SS	Aroclor-1254	50.0		UG/KG	0.04	8.8E-07
684SB032	SS	Benzo(a)pyrene Equivalents	170.8		UG/KG		2.8E-06
684SB033	SS	Aroclor-1260	71.0		UG/KG		1.2E-06
684SB033	SS	Aroclor-1254	160.0		UG/KG	0.13	2.8E-06
684SB033	SS	Benzo(a)pyrene Equivalents	259.1		UG/KG		4.3E-06
684SB034	SS	Benzo(a)pyrene Equivalents	195.7		UG/KG		3.2E-06
684SB035	SS	Benzo(a)pyrene Equivalents	29871.0		UG/KG		5.0E-04
684SB036	SS	Arsenic	11.7		MG/KG	0.53	3.1E-05
684SB036	SS	Beryllium	0.70	J	MG/KG	0.002	5.2E-06
684SB036	SS	Benzo(a)pyrene Equivalents	1162.2		UG/KG		1.9E-05

Table 6.2.3.45
COPCs Detected in SWMU 14 Surface Soils
With Corresponding Hazard Quotient and Risk Estimates
Naval Base Charleston
Charleston, SC

SITETAG	MEDIA	PARAMETER	RESULT	Q	UNITS	HQ (child)	ILCR (lwa)
684SB040	SS	Benzo(a)pyrene Equivalents	696.1		UG/KG		1.2E-05
684SB043	SS	Benzo(a)pyrene Equivalents	4266.7		UG/KG		7.1E-05
684SB044	SS	Benzo(a)pyrene Equivalents	9215.2		UG/KG		1.5E-04

SITETAG site and sample location from which the sample was collected
SS data represents surface soil
RESULT reported concentration
Q qualifier
J reported concentration was estimated by the reporting laboratory
B COPC was reported in a corresponding blank sample and could be a laboratory artifact or or originate with other exogenous sources
MG/KG milligrams per kilogram
UG/KG micrograms per kilogram
lwa lifetime weighted average
HQ hazard quotient - calculated assuming a child resident, ingestion and dermal contact pathways
ILCR incremental excess lifetime cancer risk - calculated assuming the lwa for residents, ingestion and dermal contact pathways

Table 6.2.3.46
Summary of Risk and Hazard for Combined SWMU 14
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium		Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil							
	SWMU 14	Incidental Ingestion	0.1	1	5.0E-05	0.04	5.6E-06
		Dermal Contact	0.01	0.04	8.3E-06	0.009	3.4E-06
Sum of All Pathways for SWMU 14			0.1	1	6E-05	0.04	9E-06
	SWMU 15	Incidental Ingestion	0.2	2	1.4E-04	0.1	1.7E-05
		Dermal Contact	0.05	0.2	2.4E-05	0.04	9.9E-06
Sum of All Pathways for SWMU 15			0.3	2	2E-04	0.1	3E-05
	AOC 670	Incidental Ingestion	0.1	1	5.6E-05	0.04	6.2E-06
		Dermal Contact	0.01	0.05	1.3E-05	0.01	5.4E-06
Sum of All Pathways for AOC 670			0.2	1	7E-05	0.05	1E-05
	AOC 684	Incidental Ingestion	0.08	0.7	7.8E-05	0.03	8.6E-06
		Dermal Contact	0.01	0.03	2.5E-05	0.007	9.9E-06
Sum of All Pathways for AOC 684			0.09	0.7	1E-04	0.04	2E-05
Shallow Groundwater		Ingestion	0.7	1.6	2.9E-05	0.3	6.8E-06
Sum of All Pathways for Shallow Groundwater			0.7	2	3E-05	0.3	7E-06
Deep Groundwater		Ingestion	8	17	4.9E-04	3	1.2E-04
		Inhalation	ND	ND	2.4E-06	ND	5.9E-07
Sum of All Pathways for Deep Groundwater			8	17	5E-04	3	1E-04
Combined Media Summaries							
Sum of SWMU 14 Soil/Shallow Groundwater Pathways			1	3	9E-05	0.3	2E-05
Sum of SWMU 14 Soil/Deep Groundwater Pathways			8	19	6E-04	3	1E-04
Sum of SWMU 15 Soil/Shallow Groundwater Pathways			1	4	2E-04	0.4	3E-05
Sum of SWMU 15 Soil/Deep Groundwater Pathways			8	20	7E-04	3	1E-04
Sum of AOC 670 Soil/Shallow Groundwater Pathways			0.9	3	1E-04	0.3	2E-05
Sum of AOC 670 Soil/Deep Groundwater Pathways			8	19	6E-04	3	1E-04
Sum of AOC 684 Soil/Shallow Groundwater Pathways			0.8	2	1E-04	0.3	3E-05
Sum of AOC 684 Soil/Deep Groundwater Pathways			8	18	6E-04	3	1E-04

Notes:
ND indicates not determined due to lack of available risk information
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 6.2.3.47
Residential-Based Remedial Goal Options
Naval Base Charleston, SWMU 14 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aluminum	NA	1	29600.00	218781	72927.1	7292.71	ND	ND	ND	25310
Arsenic	1.5	0.0003	13.60	66	21.9	2.19	0.383	3.83	38.3	14.81
Benzo(a)pyrene Equivalents	7.3	NA	0.93	ND	ND	ND	0.060	0.60	6.0	ND
Beryllium	4.3	0.005	1.03	1094	364.6	36.46	0.134	1.34	13.4	1.466
Chromium	NA	1	71.71	218781	72927.1	7292.71	ND	ND	ND	85.65
Manganese	NA	0.14	915.00	32850	10950.0	1095.00	ND	ND	ND	636.4
Lead	NA	NA	473.00	ND	400*	ND	ND	ND	ND	118
Thallium	NA	8E-05	0.24	18	5.8	0.58	ND	ND	ND	0.63
Vanadium	NA	0.007	67.41	1531	510.5	51.05	ND	ND	ND	77.38

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
* USEPA soil guidance concentration based on childhood exposure as predicted by IEUBK model

Table 6.2.3.48
Worker-Based Remedial Goal Options
Naval Base Charleston, SWMU 14 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aluminum	NA	1	29600.00	4348936	1449645	144965	ND	ND	ND	25310
Arsenic	1.5	0.0003	13.60	1305	435	43	2.706	27.06	270.6	14.81
Benzo(a)pyrene Equivalents	7.3	NA	0.93	ND	ND	ND	0.297	2.97	29.7	ND
Chromium	4.3	0.005	1.03	21745	7248	725	0.944	9.44	94.4	1.466
Manganese	NA	1	71.71	4348936	1449645	144965	ND	ND	ND	85.65
Lead	NA	0.14	915.00	ND	400*	ND	ND	ND	ND	636.4
Thallium	NA	8E-05	473.00	677970	225990	22599	ND	ND	ND	118
Vanadium	NA	0.007	0.24	110	37	3.7	ND	ND	ND	0.63

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
* USEPA soil guidance concentration based on childhood exposure as predicted by IEUBK model

Table 6.2.3.49
Residential-Based Remedial Goal Options
Naval Base Charleston, SWMU 15 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Arsenic	1.5	0.0003	53.10	66	21.9	2.19	0.383	3.83	38.3	14.81
Benzo(a)pyrene Equivalents	7.3	NA	2.03	ND	ND	ND	0.060	0.60	6.0	ND
Manganese	NA	0.14	506.00	30629	10209.8	1020.98	ND	ND	ND	636.4

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.3.50
Worker-Based Remedial Goal Options
Naval Base Charleston, SWMU 15 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Arsenic	1.5	0.0003	53.10	1305	435	43	2.706	27.06	270.6	14.81
Benzo(a)pyrene Equivalents	7.3	NA	2.03	ND	ND	ND	0.297	2.97	29.7	ND
Manganese	NA	0.14	506.00	608851	202950	20295	ND	ND	ND	636.4

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.3.51
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 670 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Antimony	NA	NA	10.231	88	29.2	2.92	ND	ND	ND	ND
Arsenic	1.5	NA	14.743	66	21.9	2.19	0.383	3.83	38.3	14.81
Benzo(a)pyrene Equivalents	7.3	1	1.833	ND	ND	ND	0.060	0.60	6.0	ND
Lead	NA	NA	850.318	ND	400*	ND	ND	ND	ND	118
Thallium	NA	NA	0.778	18	5.8	0.58	ND	ND	ND	0.63
Aluminum	NA	NA	15594.355	218781	72927.1	7292.71	ND	ND	ND	25310

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
* USEPA soil guidance concentration based on childhood exposure as predicted by IEUBK model

Table 6.2.3.52
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 670 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Arsenic	1.5	NA	14.743	1305	434.9	43.49	2.706	27.06	270.6	14.81
Benzo(a)pyrene Equivalents	7.3	1	1.833	ND	ND	ND	0.297	2.97	29.7	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.3.53
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 684 Surface Soils
Charleston, South Carolina

				Hazard-Based Remedial Goal Options			Risk-Based Remedial Goal Options			
	Slope Factor	Reference Dose	Unadjusted EPC	3	1	0.1	1E-06	1E-05	1E-04	Background Concentration
Chemical	(mg/kg-day)-1	(mg/kg-day)	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Antimony	NA	0.0004	5.374	88	29.2	2.92	ND	ND	ND	ND
Arsenic	1.5	0.0003	10.356	66	21.9	2.19	0.383	3.83	38.3	14.81
Benzo(a)pyrene Equivalents	7.3	NA	4.207	ND	ND	ND	0.060	0.60	6.0	ND
Beryllium	4.3	0.005	0.907	1094	364.6	36.46	0.134	1.34	13.4	1.47
Thallium	NA	8E-05	0.633	18	5.8	0.58	ND	ND	ND	0.63

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.3.54
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 684 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Arsenic	1.5	0.0003	10.356	1305	435	43.49	2.706	27.06	270.6	14.81
Benzo(a)pyrene Equivalents	7.3	NA	4.207	ND	ND	ND	0.297	2.97	29.7	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.3.55
Residential-Based Remedial Goal Options
Naval Base Charleston, Combined SWMU 14 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 3 mg/l	1 mg/l	0.1 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
Dioxin (TCDD TEQ)	150000	NA	1.14E-08	ND	ND	ND	2.21E-10	2.21E-09	2.21E-08	3E-08	ND
bis(2-Ethylhexyl)phthalate	0.014	0.02	0.0118	0.47	0.16	0.016	0.002	0.02	0.2	NA	ND
Aluminum	NA	1	15.5	23.5	7.8	0.78	ND	ND	ND	1	ND
Chromium (trivalent)	NA	1	0.0444	23.5	7.8	0.78	ND	ND	ND	0.1	ND
Lead	NA	NA	0.0197	ND	ND	ND	ND	ND	ND	0.015	ND
Vanadium	NA	0.007	0.0652	0.16	0.05	0.005	ND	ND	ND	NA	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.3.58
Worker-Based Remedial Goal Options
Naval Base Charleston, Combined SWMU 14 Deep Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 3 mg/l	1 mg/l	0.1 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
Dioxin (TCDD TEQ)	150000	NA	2.29E-08	ND	ND	ND	1.83E-09	1.83E-08	1.83E-07	0.015	ND
Heptachlor epoxide	9.1	1.3E-05	0.00324	0.004	0.001	0.0001	0.00003	0.0003	0.003	0.0002	ND
Thallium	NA	8E-05	0.0012	0.024	0.008	0.0008	ND	ND	ND	0.002	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

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Table 6.2.3.56
Worker-Based Remedial Goal Options
Naval Base Charleston, Combined SWMU 14 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 3 mg/l	1 mg/l	0.1 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
Dioxin (TCDD TEQ)	150000	NA	1.14E-08	ND	ND	ND	9.17E-10	9.17E-09	9.17E-08	NA	ND
bis(2-Ethylhexyl)phthalate	0.014	0.02	0.012	3	1	0.1	0.01	0.1	1	NA	ND
Aluminum	NA	1	15.500	147	49	5	ND	ND	ND	NA	ND
Chromium (trivalent)	NA	1	0.044	147	49	5	ND	ND	ND	NA	ND
Lead	NA	NA	0.020	ND	ND	ND	ND	ND	ND	NA	ND
Vanadium	NA	0.007	0.065	1	0.3	0.03	ND	ND	ND	NA	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.3.57
Residential-Based Remedial Goal Options
Naval Base Charleston, Combined SWMU 14 Deep Groundwater
Charleston, South Carolina

				Hazard-Based Remedial Goal Options			Risk-Based Remedial Goal Options				
Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	3 mg/l	1 mg/l	0.1 mg/l	1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
Cadmium	NA	0.0005	0.0029	0.02	0.01	0.001	ND	ND	ND	NA	ND
Chloroform	0.0061	0.01	0.002	0.5	0.2	0.02	0.001	0.01	0.1	0.1	ND
Dioxin (TCDD TEQ)	150000	NA	2.29E-08	ND	ND	ND	4.42E-10	4.42E-09	4.42E-08	0.015	ND
bis(2-Ethylhexyl)phthalate	0.014	0.02	0.0075	0.9	0.3	0.03	0.0047	0.047	0.47	NA	ND
Heptachlor epoxide	9.1	1.3E-05	0.00324	0.0006	0.0002	0.00002	7.29E-06	7.29E-05	7.29E-04	0.0002	ND
Thallium	NA	8E-05	0.0012	0.004	0.001	0.0001	ND	ND	ND	0.002	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

6.2.5 Baseline Risk Assessment for SWMU 159

6.2.5.1 Site Background and Investigative Approach

SWMU 159 was investigated to assess soil at the former SAA for temporary accumulation and storage of hazardous materials. Materials stored onsite included batteries, aerosol cans, and paint waste. An AST containing diesel fuel, a can crusher, and small debris piles are also at the SWMU. SWMU 159 is near Building 665 in the south-central portion of Zone H. Sixteen soil samples were collected from the surface interval (0 to 1 foot deep). Table 6.2.5.1 shows each surface soil designation and lists analytical methods used. Groundwater was not sampled.

Two sediment samples were collected from a tidal estuary topographically downgradient of the site. Analytical results for these samples are presented in Section 4. The area from which the samples were collected is adjacent to a storm water outfall which drains nearby parcels including SWMU 159. This area is flooded by water originating in Shipyard Creek and surface runoff from adjacent parking lots for more than half of the year. Because of possible infrequent contact, this medium was formally addressed. A single surface water sample was collected from the same tidal estuary near the storm water outfall. The surface water analytical results for this sample are discussed below. Surface water and sediment samples were analyzed for volatile and semivolatile organics, chlorinated pesticides, PCBs, inorganics, and indeterminate lubricating oil.

6.2.5.2 COPC Identification

Soil

Surface soil data and screening values used in the screening comparison for SWMU 159 soil are summarized in Table 6.2.5.2. As shown in the table, cPAHs (as BEQs) and aluminum were the only identified soil COPCs. Indeterminate lubricating oil was identified in all 16 surface soil samples. The oil concentrations ranged from 29 to 170 mg/kg. The soil AL of 100 mg/kg established for petroleum hydrocarbons at NAVBASE was exceeded in multiple samples.

Surface Water

As described in Section 4, no organic compounds were detected in the surface water sample collected in conjunction with the SWMU 159 RFI. No reference (background) surface water data were collected as part of the Zone H RFI. Extensive surface water sampling is planned for the Zone J RFI, which will include collecting samples from reference surface waters which will be used to assess the relevance of concentrations reported in Zone H site-specific investigations. As discussed in Section 4, arsenic (2.8 μg/L) and manganese (312 μg/L) were the only surface water constituents detected in the sample above their corresponding risk-based screening values. Both are naturally occurring elements, and their presence in SWMU 159 surface water is not unexpected. Surface water risk was not formally assessed at SWMU 159 pending results of reference area sampling as part of the Zone J RFI.

Sediment

Sediment data and screening values used in the screening comparison for SWMU 159 sediment are summarized in Table 6.2.5.3. As shown in the table, cPAHs (BEQs), heptachlor epoxide, chlordane (alpha and gamma isomers), aluminum, and arsenic were the only identified soil COPCs. Indeterminate lubricating oil was identified in both sediment samples at concentrations ranging from 52 to 2,000 mg/kg. The soil AL of 100 mg/kg was exceeded in one sample. The residential soil RBCs were used as the risk-based screening values for sediment, and surface soil reference concentrations were used to evaluate results relative to naturally occurring levels. The residential RBCs provide a conservative screening approach. Surface soil reference concentrations were used to provide a reasonable account of potential ambient sediment quality.

6.2.5.3 Exposure Assessment

Exposure Setting

The exposure setting at SWMU 159 is a small, essentially undeveloped area (less than two-thirds of an acre) close to Building 665. Currently, a diesel fuel AST occupies a portion of the area along with a can crusher and small debris piles. The site is the former location of an SAA for batteries, aerosol cans, and paint waste. The marshy area south of the SWMU was formally assessed for potential sediment exposures.

The site is expected to remain commercial/industrial property. SWMU 159 is within an area proposed to become a marine industrial park and/or open buffer (potential recreational) area under current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations include current and future site workers as well as hypothetical future site residents. Because many traditional activities at NAVBASE have ceased or are expected to cease in the near future, current site workers were not specifically addressed in the formal assessment. Due to the lack of specific knowledge regarding the functions that will be performed by future site workers, a standard default scenario was developed. A similar approach was applied for future site residents. Adolescent trespassers were considered as a possibly exposed population with respect to sediments.

Exposure Pathways

Exposure pathways for future site workers and site residents were based on an evaluation of the impacted media identified at SWMU 159. Relative to the soil matrix, incidental ingestion and dermal contact were considered viable exposure pathways. Groundwater exposure pathways were not considered because this matrix was not included in the RFI scope. Uniform exposure was assumed for all sample locations. For the sediment matrix, adolescent trespasser exposures were evaluated via incidental ingestion and dermal contact pathways. The exposure assumptions applied to evaluate these pathways are described below. Table 6.2.5.4 presents the exposure pathway selection process and justifies each pathway evaluated.

Adolescent trespassers (ages 7 to 16) were assumed to gain access to the SWMU 159 area one day per week (52 days/year). Because the marshy area from which sediment samples were collected is flooded at least 50% of the time, sediment exposure frequency was assumed to be 26 days/year. The trespassers will have an exposure duration of 10 years. The sediment ingestion rate was set at 100 mg/day, and the contact surface area was conservatively established as 4,100 cm^2/event (at one event/day). The body weight of the adolescent trespasser was assumed to be 45 kilograms.

Exposure Point Concentrations

At SWMU 159, 16 surface soil samples were collected. A UCL based exposure quantification process was not warranted on contaminant distributions in surface soil. For aluminum, the maximum concentration was used as the EPC in surface soil. BEQs were reported at three locations (159SB001, 159SB010, and 159SB011) at concentrations ranging from 0.00018 to 0.128 mg/kg. These three sampling locations became the primary focus relative to BEQs and exposure quantification, due to the isolation of the soil impacts. Sample 159SB011 contained the greatest quantity of BEQs, and was the point at where the residential RBC was exceeded. A conservative estimate indicates that this location could represent soil quality over 10% of the total SWMU area. As the initial step in evaluating reasonable maximum exposure, the BEQ concentration reported in sample 159SB011 was used as the EPC. The implications of the alternate hot spot (FI/FC) approach to assessing BEQs in SWMU 159 surface soil are discussed in Section 6.2.5.5.

Because only two sediment samples were collected, the maximum concentration of each identified COPC was used as the EPC for this medium.

Quantification of Exposure

Soil

Tables 6.2.5.5 and 6.2.5.6 present CDIs for the ingestion and dermal contact pathways, respectively.

Sediment

Tables 6.2.5.7 and 6.2.5.8 present CDIs for the sediment ingestion and dermal contact pathways, respectively.

6.2.5.4 Toxicity Assessment

Table 6.2.5.9 presents the toxicological information used to quantify risk associated with exposure to surface soil and sediment COPCs at SWMU 159. The following paragraphs present the brief toxicological profiles as well as toxicological values (SFs and RfD) used to project risk/hazard based on computed CDI as well as discussions of the potential toxic effects and target organs for each.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), BAP B2 classification is based on insufficient human data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified (see Additional Comments for Oral Exposure). This section provides information on three aspects of the carcinogenic risk assessment for the agent in question — the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and is presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, dibenz(a,h)anthracene and benzo(b)fluoranthene are classified a B2 due to human data but sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting.

As listed in IRIS, benzo(a)anthracene and benzo(k)fluoranthene B2 classifications are based on no human data but sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other ***PAHs*** — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene***. USEPA determined RfDs for only two of these compounds: pyrene's RfD_o is 0.03 mg/kg-day, and this RfD is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was 0.06 mg/kg-day.

Heptachlor is an insecticide that was used to control flies, mosquitoes, and field insects (Dreisbach, et al., 1987). USEPA determined this compound to be a class B2 carcinogen, and determined the SF_o to be 4.5 $(mg/kg\text{-}day)^{-1}$. As listed in IRIS (search date 6/29/95), the classification is based on inadequate human data, but sufficient evidence from studies in which benign and malignant liver tumors were induced in three strains of mice of both sexes. Several structurally related compounds are liver carcinogens. The primary target organs for this pesticide are the liver and kidneys, and USEPA determined the RfD_o to be 0.0005 mg/kg-day. As listed in IRIS, the critical effect of this chemical is liver weight increases in males. The uncertainty factor was 300 and the modifying factor was 1.

Heptachlor epoxide is the more toxic form of the insecticide heptachlor (Dreisbach et al., 1987). USEPA determined this compound to be a class B2 carcinogen, and determined the SF_o to be 9.1 $(mg/kg\text{-}day)^{-1}$. The primary target organs for this pesticide are the liver and kidneys, and USEPA determined the RfD_o to be 1.3E-5 mg/kg-day.

Chlordane is a polycyclic chlorinated pesticide. Acute exposure to high doses of chlordane causes tremors and convulsions. Chronic exposure can cause emotional and neuromuscular disturbances. Exposed individuals revert to normal approximately one week after the source is removed (Dreisbach et al., 1987). USEPA determined this compound to be a class B2 carcinogen, and determined the SF_o to be 1.3 $(mg/kg\text{-}day)^{-1}$. USEPA determined the RfD_o to be 6E-5 mg/kg-day.

Aluminum, one of the most abundant metals in the earth's crust (7% aluminum), is ubiquitous in air and water as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can potentially interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions. These contractions are part of the neuro-muscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen et al., 1986; Dreisbach et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based secondary MCL for drinking water is 50 to 200 μg/L (USEPA, Office of Water).

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on an NOAEL of 0.8 μg/kg per day in a human exposure study. Arsenic's effect on the nervous and cardiovascular systems is primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has caused cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingesting these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. As listed in IRIS (search date 9/1/95), the classification is based on sufficient evidence from human data. Increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 $\mu g/L$ arsenic. The RBC for arsenic in tap water is 0.038 $\mu g/L$. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

6.2.5.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Tables 6.2.5.10 and 6.2.5.11 present the computed carcinogenic risk and noncarcinogenic HQs associated with the incidental ingestion and dermal contact with surface soil, respectively.

Future Site Residents

The projected ingestion related ILCR from surface soil was 1E-6, and the dermal pathway risk was 7E-7. BEQs were the sole contributor for both pathways. The resident child HIs for incidental ingestion and dermal contact pathways were 0.4 and 0.03, respectively. Aluminum accounted for the noncarcinogenic hazard.

When FI/FC from contaminated source are considered, a linear reduction in the computed CDI occurs. As stated in Section 6.2.5.3, the limited area in which BEQs were detected represents approximately one-tenth of the total area investigated (two-thirds of an acre). Due to the direct relationship between CDI and projected risk/hazard, the projected carcinogenic risk to future site residents considering FI/FC would be 2E-7 (incidental ingestion and dermal contact combined), which is less than the most stringent point of departure (1E-6). This approach is consistent with USEPA Region IV guidance; however, it is not formally presented due to distribution of BEQs observed onsite. Sample 159SB011 was the only sample that contained BEQs exceeding the residential RBC, although lower concentrations were detected in 159SB010 and 159SB001.

Future Site Workers

The projected ingestion-related ILCR from surface soil was 2E-7, and the dermal pathway risk was 3E-7. BEQs were the sole contributor for both pathways. The site worker HIs for incidental ingestion and dermal contact pathways were equal to or less than 0.01.

Because site worker risk projections did not exceed the most conservative 1E-6 point of departure assuming that all surface soil was accessible for contact exposure, no formal assessment was necessary considering the influences of existing site features or FI/FC. The area in and around SWMU 159 can be characterized as bare ground, vegetated soil, and asphalt surfaces. The samples combining BEQs were collected next to an asphalt drive.

Sediment Exposure Pathways

Exposure to sediment onsite was evaluated under an adolescent trespasser land use scenario. For this scenario, the incidental ingestion and dermal contact exposure pathways were considered. Tables 6.2.5.12 and 6.2.5.13 present the computed carcinogenic risk and noncarcinogenic HQs associated with the incidental ingestion and dermal contact with sediment, respectively.

Potential Adolescent Trespassers

The projected ingestion-related ILCR from sediment was 7E-7 and the dermal pathway risk was 2E-7. Arsenic was the primary contributor for both pathways. The adolescent trespasser HIs for incidental ingestion and dermal contact pathways were 0.02 and 0.01, respectively. Aluminum and arsenic accounted for most of the noncarcinogenic hazard.

Due to the biased nature of the sediment sampling effort, the CDI and resultant risk/hazard projections for sediment pathways are expected to be overestimates. The EPCs for each sediment COPC were assumed to be the maximum concentration detected. Because the most heavily impacted sediment sample (159M0001) was collected at a storm drain outfall, the presence of semivolatile cPAHs would be expected, originating with nearby asphalt surfaces. The projected risk for the pathway did not exceed the most stringent 1E-6 point of departure, and therefore, a more detailed assessment was not warranted.

COCs Identified

Based on the evaluation of surface soil exposure pathways presented above, COCs were identified in surface soil exclusively for the future site resident scenario at SWMU 159. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or an HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is comparatively conservative because USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

Surface Soil

Hypothetical Site Residents

BEQs were identified as the sole COCs for this scenario based on the sum ILCR.

Hypothetical Site Workers

No COCs were identified for this scenario based on the sum ILCR and HI.

Due to the limited extent of identified soil impacts, graphical presentation of risk projections for SWMU 159 surface soil was determined to be of limited use. Section 6.2.5.3 discusses the distribution of BEQs identified in surface soil at SWMU 159.

Sediment

Potential Adolescent Trespassers

No COCs were identified for this scenario based on the sum ILCR and HI.

6.2.5.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Under current site use conditions, workers may be infrequently exposed to surface soils sampled during the RFI when walking across the site or using the AST buildings and parking lot. Based on current operations, however, the potential for extended or typically defined chronic exposure is very low.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current plans call for continued use as nonresidential maintenance property, specifically a marine industrial park and/or open buffer space (undeveloped land). To develop the site for residential purposes, the asphalt road and parking surfaces would be removed. There is a high probability that the cPAHs in surface soil are associated with these materials. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. A conservative estimate of FI/FC was made to provide a refined approach to exposure quantification, although the actual impacted fraction of the site is likely less than 10%. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Trespass use of the adjacent marsh is a reasonable, if not likely, potential exposure scenario. This periodically flooded area south of SWMU 159 does not provide any extraordinary attraction for adolescents. Even so, it is possible that young people (ages 7 to 16) could infrequently play in this area.

Determination of Exposure Point Concentrations

The maximum concentration reported for BEQs was conservatively applied as the EPC for the site. The maximum aluminum concentration in surface soil was used as the EPC for this parameter. As a result, the quantification of exposure does not account for potential variability in the aluminum concentrations in the soil matrix. The maximum concentration of each sediment COPC was applied as the EPC.

Frequency of Detection and Spatial Distribution

A UCL-based EPC was dismissed for BEQs because it would unacceptably suggest widespread presence of these chemicals. As a result, the maximum concentration of BEQs detected at SWMU 159 was applied as the EPC although an alternate hot spot approach was considered as part of the risk characterization as discussed in Section 6.2.5.5. A conservative FI/FC factor was estimated assuming that the analytical results at location 159SB011 were indicative of surface soil quality over 10% of the SWMU. Confidence in this assumption is moderate to high since the extent of cPAH impacts was well-delineated.

All cPAH hits were J-qualified; therefore, confidence in the quantitation is relatively low. Elevated indeterminenate lubricating oil (or DRO) results (29 to 170 mg/kg) were reported in soil onsite.

In sediment, cPAH detections were reported almost exclusively in one of two samples. As a result, the potential for chronic exposure at the EPC is remote.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of arsenic, beryllium, manganese, and vanadium exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding reference concentrations. They were eliminated from formal assessment based on comparisons to the reference concentrations because they did not contribute to excess risk/hazard onsite. Wilcoxon rank sum tests found that the overall concentration distribution for these elements did not differ appreciably from that in background surface soil samples.

The samples in which BEQs were present were collected directly beneath or close to asphalt surfaces. BAP and other cPAHs are constituents of asphalt and their presence is not necessarily attributable to past or current site operation.

Although the future land use of SWMU 159 is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimate risk and/or hazard. An individual map was not produced for this site.

The CT assumption for residential exposure duration is nine years, compared to the 30-year assumption for RME. If all other exposure assumptions remain fixed, application of the CT exposure duration would result in risk projections 66% below the RME. At CT, the surface soil-related risk (incidental ingestion and dermal contact) would fall well below the 1E-6 point of departure.

Sediment

Of the CPSSs eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of aluminum, arsenic, beryllium, chromium, and manganese exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding surface soil reference concentrations. They were eliminated from formal assessment because, based on comparisons to the reference concentrations, they did not contribute to excess risk/hazard. Use of surface soil reference concentrations was deemed a reasonably conservative means of assessing the significance of detected sediment concentrations.

6.2.5.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 159 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed. No surface soil COCs were identified. Table 6.2.5.14 summarizes risk for the combined incidental ingestion and dermal pathways for SWMU 159.

6.2.5.8 Remedial Goal Options

Soil

RGOs were calculated for the future site resident based on the RME risk estimates presented in Section 6.2.5.5, and are presented in Table 6.2.5.15. An alternate set of RGOs developed in consideration of estimated FI/FC are also presented in Table 6.2.5.15.

Table 6.2.5.1
Methods Run at SWMU 159
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
159	B001	S	S	S	Y	Y	Y	Y	Y	S		Y	Y			
159	B002	S	S	S	Y					S		Y	Y			
159	B003	S	S	S	Y					S		Y	Y			
159	B004	S	S	S	Y					S		Y	Y			
159	B005	S	S	S	Y					S		Y	Y			
159	B006	S	S	S	Y					S		Y	Y			
159	B007	S	S	S	Y					S		Y	Y			
159	B008	S	S	S	Y					S		Y	Y			
159	B009	S	S	S	Y					S		Y	Y			
159	B010	S	S	S	Y					S		Y	Y			
159	B011	S	S	S	Y	Y	Y	Y	Y	S		Y	Y			
159	B012	S	S	S	Y					S		Y	Y			
159	B013	S	S	S	Y					S		Y	Y			
159	B014	S	S	S	Y					S		Y	Y			
159	B015	S	S	S	Y					S		Y	Y			
159	B016	S	S	S	Y					S		Y	Y			

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.5.2
SWMU 159
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	1/ 16	10.00 -	44.00	41.000 -	41.000	41.000	780000.0000			
* Aluminum	MG/KG	16/ 16			3190.000 -	29300.000	8372.500	7800.0000	5	25310.000	1
Arsenic	MG/KG	16/ 16			0.780 -	12.800	3.936	0.3700	16	14.810	
Barium	MG/KG	14/ 16	5.70 -	10.10	11.500 -	47.100	17.764	550.0000		40.330	1
* Benzo(a)pyrene Equivalents	UG/KG	16/ 16			33.225 -	127.450	65.808	88.0000	1		
Benzo(a)anthracene	UG/KG	1/ 16	330.00 -	610.00	160.000 -	160.000	160.000				
Benzo(b)fluoranthene	UG/KG	1/ 16	330.00 -	610.00	100.000 -	100.000	100.000				
Chrysene	UG/KG	2/ 16	330.00 -	500.00	150.000 -	180.000	165.000				
Benzo(k)fluoranthene	UG/KG	1/ 16	330.00 -	610.00	130.000 -	130.000	130.000				
Benzo(a)pyrene	UG/KG	2/ 16	380.00 -	610.00	19.500 -	100.000	59.750				
Beryllium	MG/KG	3/ 16	0.05 -	0.46	0.110 -	1.200	0.496	0.1500	2	1.470	
Cadmium	MG/KG	9/ 16	0.10 -	0.15	0.120 -	0.410	0.247	3.9000		1.050	
Calcium	MG/KG	16/ 16			863.000 -	26700.000	7854.625				
alpha-Chlordane	UG/KG	12/ 16	4.00 -	4.00	4.100 -	120.000	31.245	470.0000			
gamma-Chlordane	UG/KG	12/ 16	4.00 -	4.00	1.900 -	130.000	37.625	470.0000			
Chromium	MG/KG	16/ 16			4.900 -	72.300	14.709	39.0000	1	85.650	
Cobalt	MG/KG	1/ 16	0.36 -	3.20	6.400 -	6.400	6.400	470.0000		5.860	1
Copper	MG/KG	10/ 16	1.80 -	3.60	3.350 -	46.100	11.775	290.0000		27.600	1
Total Cresol	PG/G	2/ 2			64.610 -	284.390	174.500				
2,4-D	UG/KG	1/ 2	50.00 -	50.00	20.200 -	20.200	20.200	78000.0000			
4,4'-DDE	UG/KG	12/ 16	4.00 -	4.00	2.200 -	16.000	6.700	1900.0000			
4,4'-DDT	UG/KG	3/ 16	3.30 -	50.00	3.800 -	5.600	4.933	1900.0000			
Dioxin (TCDD TEQ)	PG/G	2/ 2			3.887 -	9.014	6.451	1000.0000			
Endrin	UG/KG	1/ 16	3.30 -	20.00	2.500 -	2.500	2.500	2300.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	4/ 16	330.00 -	500.00	100.000 -	190.000	140.000	46000.0000			
Fluoranthene	UG/KG	3/ 16	380.00 -	610.00	24.600 -	187.300	113.966	310000.0000			
Heptachlor	UG/KG	1/ 16	1.70 -	20.00	2.300 -	2.300	2.300	140.0000			
Heptachlor epoxide	UG/KG	2/ 16	1.70 -	20.00	2.700 -	3.600	3.150	70.0000			
* Indeterminate Lubricating Oil	UG/KG	16/ 16			29000.000 -	170000.000	64843.750	10.0000	16		
Iron	MG/KG	16/ 16			2750.000 -	32800.000	6667.500			30910.000	1
Lead	MG/KG	16/ 16			4.300 -	92.000	18.662	400.0000i		118.000	
Magnesium	MG/KG	16/ 16			168.000 -	4860.000	863.875			9592.000	
Manganese	MG/KG	16/ 16			11.700 -	307.000	64.887	39.0000	8	636.400	
Mercury	MG/KG	7/ 16	0.02 -	0.04	0.030 -	0.150	0.070	2.3000		0.490	

Table 6.2.5.2
SWMU 159
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Nickel	MG/KG	16/ 16		0.940 - 16.300	3.458	160.0000		33.380	
Phenanthrene	UG/KG	1/ 16	330.00 - 610.00	310.000 - 310.000	310.000	310000.0000k			
Potassium	MG/KG	2/ 16	113.00 - 320.00	579.000 - 1670.000	1124.500				
Pyrene	UG/KG	3/ 16	380.00 - 610.00	25.900 - 145.900	89.266	230000.0000			
Selenium	MG/KG	16/ 16		0.440 - 2.300	0.880	39.0000		2.000	1
Silver	MG/KG	1/ 16	0.16 - 0.25	0.530 - 0.530	0.530	39.0000			
Sodium	MG/KG	13/ 16	36.30 - 87.50	111.000 - 2500.000	640.230				
2,4,5-T	UG/KG	2/ 2		11.300 - 53.500	32.400	78000.0000			
2,4,5-TP (Silvex)	UG/KG	2/ 2		12.900 - 30.000	21.450	63000.0000			
Trichloroethene	UG/KG	14/ 16	5.00 - 6.00	3.300 - 21.000	9.642	47000.0000			
Vanadium	MG/KG	15/ 16	4.50 - 4.50	5.300 - 62.600	13.670	55.0000	1	77.380	
Zinc	MG/KG	15/ 16	14.70 - 14.70	7.400 - 101.000	34.760	2300.0000		214.300	

Notes:
- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.5.3
SWMU 159
Sediment

	Parameter	Units	Frequency of Detection	Range of Non Detected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
	Acetone	UG/KG	1/2	10 - 10	210 - 210	210	780000			
*	Aluminum	MG/KG	2/2	-	4640 - 32900	18770	7800	1	25310	1
	Antimony	MG/KG	1/2	-	2.1 - 2.1	2.1	3.1			
*	Arsenic	MG/KG	2/2	-	11.5 - 15.5	13.5	0.37	2	14.81	1
	Barium	MG/KG	2/2	-	29 - 62.1	45.55	550		40.33	1
*	Benzo(a)pyrene Equivalents	UG/KG	2/2	-	0.19 - 594.9	297.5	88	1		
	Benzo(a)anthracene	UG/KG	1/2	-	540 - 540	540				
	Benzo(a)pyrene	UG/KG	1/2	-	470 - 470	470				
	Benzo(b)fluoranthene	UG/KG	1/2	-	430 - 430	430				
	Benzo(k)fluoranthene	UG/KG	1/2	-	530 - 530	530				
	Chrysene	UG/KG	2/2	-	190 - 510	350				
	Indeno(1,2,3-cd)pyrene	UG/KG	1/2	-	270 - 270	270				
	Benzo(g,h,i)perylene	UG/KG	1/2	-	270 - 270	270	310000			
	Beryllium	MG/KG	2/2	-	0.22 - 1.1	0.66	0.15	2	1.47	
	2-Butanone	UG/KG	1/2	10 - 10	43 - 43	43	47000000			
	Butylbenzylphthalate	UG/KG	1/2	-	210 - 210	210	1600000			
	Cadmium	MG/KG	2/2	-	0.55 - 1	0.775	3.9		1.05	
	Calcium	MG/KG	2/2	-	11600 - 15400	13500				
*	alpha-Chlordane	UG/KG	2/2	1.7 - 1.7	99 - 560	329.5	490	1		
*	gamma-Chlordane	UG/KG	2/2	1.7 - 1.7	84 - 760	422	490	1		
	Chromium	MG/KG	2/2	-	40.8 - 68.6	54.7	39	2	85.65	
	Cobalt	MG/KG	2/2	-	2.9 - 6.4	4.65	470		5.86	1
	Copper	MG/KG	2/2	-	22.6 - 29.4	26	290		27.6	1
	Fluoranthene	UG/KG	2/2	-	230 - 920	575	310000			
	Heptachlor	UG/KG	1/2	1.7 - 1.7	62 - 62	62	140			
*	Heptachlor epoxide	UG/KG	1/2	1.7 - 1.7	72 - 72	72	70	1		
*	Indeterminate Lubric. Oil	UG/KG	2/2	-	52000 - 2000000	1026000	100000	1		
	Iron	MG/KG	2/2	-	29100 - 34200	31650			30910	1
	Lead	MG/KG	2/2	-	47.4 - 89.1	68.25	400		118	
	Magnesium	MG/KG	2/2	-	1440 - 5050	3245				
	Manganese	MG/KG	2/2	-	104 - 245	174.5	39	2	636.4	
	Mercury	MG/KG	2/2	-	0.07 - 0.15	0.11	2.3		0.49	
	Nickel	MG/KG	2/2	-	11.9 - 14.3	13.1	160		33.38	

Table 6.2.5.3
SWMU 159
Sediment

	Parameter	Units	Frequency of Detection	Range of Non Detected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
	Phenanthrene	UG/KG	1/2	-	310 - 310	310	310000 f			
	Potassium	MG/KG	2/2	-	367 - 1660	1013.5				
	Pyrene	UG/KG	2/2	-	260 - 720	490	230000			
	Selenium	MG/KG	2/2	-	2.3 - 2.7	2.5	39			
*	Silver	MG/KG	2/2	-	0.43 - 0.54	0.485	39			
	Sodium	MG/KG	2/2	-	1280 - 2590	1935				
	Trichloroethene	UG/KG	1/2	10 - 10	17 - 17	17	58000			
	Vanadium	MG/KG	2/2	-	22.6 - 66.2	44.4	55	1	77.38	
	Zinc	MG/KG	2/2	-	92.4 - 279	185.7	2300		214.3	1
	bis(2-Ethylhexyl)phthalate	UG/KG	2/2	-	280 - 2400	1340	46000			

NOTES:

f indicates the residential soil RBC for fluoranthene was used as a surrogate value.

* indicates the parameter was identified as a COPC.

Table 6.2.5.4
Exposure Pathways Summary — SWMU 159
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for SWMU 159, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 159.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 159.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Sediment, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Sediment, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult), Site Trespasser, and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for SWMU 159, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Risk-based screening was performed on shallow groundwater data. No COPCs were identified at this site. Therefore, shallow groundwater was not addressed formally.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Risk-based screening was performed on shallow groundwater data. No VOCs were identified as shallow groundwater COPCs at this site.

Table 6.2.5.4
Exposure Pathways Summary — SWMU 159
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Sediment, Incidental ingestion	Yes	Current sediment conditions were assessed for the hypothetical adolescent trespasser. Sediment is exposed approximately 50% of the time, which was reflected in the exposure estimates for site trespassers.
	Sediment, Dermal contact	Yes	Current sediment conditions were assessed for the hypothetical adolescent trespasser. Sediment is exposed approximately 50% of the time, which was reflected in the exposure estimates for site trespassers.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.5.5
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 159
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene equivalents	1	0.128	1.75E-07	1.63E-06	2.00E-07	6.24E-08	2.23E-08
Aluminum	NA	29300	4.01E-02	3.75E-01	4.59E-02	1.43E-02	5.12E-03

NOTES:

TEF	toxic equivalency factor relative to Benzo(a)pyrene
lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk

Table 6.2.5.6
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 159
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene equivalents	1	0.128	0.01	7.16E-08	2.36E-07	4.48E-08	5.11E-08	1.83E-08
Aluminum	NA	29300	0.001	1.65E-03	5.43E-03	1.03E-03	1.18E-03	4.20E-04

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.5.7
Chronic Daily Intakes (CDI)
Incidental Ingestion of Sediment (0-1')
SWMU 159
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Adolescent Trespasser H-CDI (mg/kg-day)	Potential Future Adolescent Trespasser C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.595	9.42E-08	1.35E-08
Heptachlor epoxide	NA	0.072	1.14E-08	1.63E-09
Heptachlor	NA	0.062	9.81E-09	1.40E-09
Chlordane (alpha & gamma)	NA	1.32	2.09E-07	2.98E-08
Aluminum	NA	32900	5.21E-03	7.44E-04
Arsenic	NA	15.5	2.45E-06	3.51E-07

NOTES:

TEF toxic equivalency factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF.

Table 6.2.5.8
Chronic Daily Intakes (CDI)
Dermal Contact with Sediment (0-1')
SWMU 159
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.595	0.01	3.86E-08	5.52E-09
Heptachlor epoxide	NA	0.072	0.01	4.67E-09	6.68E-10
Heptachlor	NA	0.062	0.01	4.02E-09	5.75E-10
Chlordane (alpha & gamma)	NA	1.32	0.01	8.57E-08	1.22E-08
Aluminum	NA	32900	0.001	2.14E-04	3.05E-05
Arsenic	NA	15.5	0.001	1.01E-07	1.44E-08

NOTES:

TEF Toxic Equivalency Factor relative to benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF.

able 6.2.5.9 - SWMU 159
oxicological Database Information
r Chemicals of Potential Concern
AVBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

hemical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation
luminum	1	e			ND	ND			ND
rsenic	0.0003	a	M	hyperpigmentation	3	ND			ND
enzo(a)pyrene Equivalents	ND				ND	ND			ND
eptachlor	0.0005	a	L	liver weight increase	300	ND			ND
eptachlor epoxide	0.000013	a	L	liver weight increase	1000	ND			ND
hlordane	6E-05	a	L	liver hypertrophy		ND			ND

NOTES:

a Integrated Risk Information System (IRIS)
e EPA Environmental Criteria and Assessment Office - Cincinnati (provisional)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

ɔle 6.2.5.9 - SWMU 159
ɤicological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Carcinogenic Toxicity Data

emical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
ıminum	ND		ND		ND	
ɜenic	1.5	a	15.1	a	A	various
nzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
·ptachlor	4.5	a	ND		B2	liver tumors
·ptachlor epoxide	9.1	a	ND		B2	liver carcinoma
ılordane	1.3	a	ND		B2	liver carcinoma

Table 6.2.5.10
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 159
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	1.5E-06	ND	1.6E-07
Aluminum	1	NA	0.04	0.4	ND	0.01	ND
			0.04	0.4	1E-06	0.01	2E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.5.11
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 159
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	6.5E-07	ND	2.7E-07
Aluminum	0.2	0.2	NA	0.01	0.03	ND	0.01	ND
NOTES:				0.01	0.03	7E-07	0.01	3E-07

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.5.12
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Sediment Ingestion
SWMU 159
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Adolescent Trespasser Hazard Quotient	Potential Future Adolescent Trespasser ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	9.8E-08
Heptachlor epoxide	1.3E-05	9.1	0.001	1.5E-08
Heptachlor	0.0005	4.5	0.00002	6.3E-09
Chlordane (alpha & gamma)	6E-05	1.3	0.003	3.9E-08
Aluminum	1	NA	0.01	ND
Arsenic	0.0003	1.5	0.01	5.3E-07
SUM Hazard Index/ILCR			0.02	7E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.5.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact with Sediment
SWMU 159
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Adjusted Oral SF Used (mg/kg-day)-1	Potential Future Adolescent Trespasser Hazard Quotient	Potential Future Adolescent Trespasser ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	8.1E-08
Heptachlor epoxide	0.5	6.5E-06	18.2	0.001	1.2E-08
Heptachlor	0.5	0.00025	9	0.00002	5.2E-09
Chlordane (alpha & gamma)	0.5	3E-05	2.6	0.003	3.2E-08
Aluminum	0.2	0.2	NA	0.001	ND
Arsenic	0.2	6E-05	7.5	0.002	1.1E-07
SUM Hazard Index/ILCR				0.01	2E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.5.14
Summary of Risk and Hazard for SWMU 159
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)	HI (Trespasser)	ILCR (Trespasser)
Surface Soil	Incidental Ingestion	0.04	0.4	1.0E-06	0.01	2E-07	NA	NA
	Dermal Contact	0.01	0.03	7.0E-07	0.01	3E-07	NA	NA
Sediment	Incidental Ingestion	NA	NA	NA	NA	NA	0.02	7E-07
	Dermal Contact	NA	NA	NA	NA	NA	0.01	2E-07
Sum of All Pathways		0.05	0.4	2E-06	0.02	5E-07	0.03	9E-07

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
NA indicates not applicable

Table 6.2.5.15
Residential-Based Remedial Goal Options
Naval Base Charleston, SWMU 159 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene equivalents	7.3	NA	0.128	ND	ND	ND	0.06	0.60	6.0	ND
				RGOs based on fraction ingested/ contacted from contaminated source *			0.60	6.0	60	

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
* a FI/FC factor of 0.1 was conservatively estimated for SWMU 159. Application of this factor was not made in the formal assessment due to uncertainty regarding BEQ distributions outside the most highly impacted area.

6.2.6 Baseline Risk Assessment for SWMU 178

6.2.6.1 Site Background and Investigative Approach

SWMU 178, approximately 50 feet south of Building X33-A, was investigated to assess soil and groundwater near a leaking transformer. Six surface soil samples were collected. Table 6.2.6.1 shows each surface soil sample designation and analytical methods used for each corresponding sample. Groundwater samples collected from two shallow monitoring wells were analyzed for a list of parameters similar to those for soil samples. First- and second-quarter groundwater data were used along with soil data as the bases for this HHRA. Groundwater samples are listed in Tables 6.2.6.2 and 6.2.6.3 for the first and second quarters, respectively.

6.2.6.2 COPC Identification

Soil

Surface soil data and screening values used in the screening comparison for SWMU 178 soil are summarized in Table 6.2.6.4. As shown in the table, BEQs equivalents were the only identified soil COPCs. The results of Wicoxon rank sum test background comparisons of inorganic CPSS that exceeded their corresponding risk-based screening values did not identify any additional COPCs. Therefore, surface soil was formally assessed considering BEQs. TPH was identified in five of six surface soil samples analyzed at concentrations ranging between 140 and 900 mg/kg. These concentrations exceed the NAVBASE soil AL of 100 mg/kg.

Groundwater

Shallow groundwater data and screening values used in the screening comparisons for SWMU 178 groundwater are summarized in Tables 6.2.6.5 and 6.2.6.6 for first- and second-quarter results. No groundwater COPCs were identified based on sampling results from first or second quarter. The results of Wilcoxon rank sum test background comparisons of inorganic CPSSs that exceeded their corresponding risk-based screening values did not identify any COPCs.

6.2.6.3 Exposure Assessment

Exposure Setting

The exposure setting at SWMU 178 is a small fenced area with bare soil and grass around a recently discovered transformer oil leak. The site is approximately 50 feet south of Building X33-A.

The future use of the site is not definite; however, it is anticipated to continue to be commercial/industrial property. SWMU 178 is an area proposed to become a cargo terminal and general office/training facility under current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations include current and future site workers as well as hypothetical future site residents. Because many traditional activities at NAVBASE have ceased or are expected to cease in the near future, current site workers were not specifically addressed in the formal assessment. Due to the lack of knowledge regarding the specific functions that will be performed by future site workers, a standard default scenario was developed for these individuals. A similar approach was applied for future site residents.

Exposure Pathways

Exposure pathways for future site workers and site residents were based on an evaluation of the impacted media identified at SWMU 178. Relative to the soil matrix, incidental ingestion and dermal contact were considered as viable exposure pathways. Groundwater ingestion exposure pathway was considered, but inhalation was excluded from the assessment because no volatile COPCs were identified. Uniform exposure was assumed for all sample locations. Table 6.2.6.7 presents the exposure pathway selection process and justifies each pathway evaluated.

Exposure Point Concentrations

At SWMU 178, fewer than 10 samples were collected from each potential exposure medium. As a result, the maximum concentration of each COPC identified in soil was used as the EPC.

Quantification of Exposure

Soil

Tables 6.2.6.8 and 6.2.6.9 present CDIs for the ingestion and dermal contact pathways, respectively.

6.2.6.4 Toxicity Assessment

Carcinogenic PAHs (or BEQs) were the only COPCs identified at SWMU 178. The following paragraphs present a brief toxicological profiles and the toxicological values (SFs and RFIs) used to project risk/hazard based on computed CDI and discuss the potential toxic effects and target organs for each.

Polyaromatic hydrocarbons include the following COPCs:

	TEF
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Dibenz(a,h)anthracene	1.0
Benzo(k)fluoranthene	0.01
Benzo(a)pyrene	1.0
Indeno(1,2,3-cd)pyrene	0.1
Chrysene	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most CPAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the BAP B2 classification is based on insufficient human data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified (see Additional Comments for Oral Exposure). This section provides information on three aspects of the carcinogenic risk assessment for the agent in question — the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg-day). The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity. As listed in IRIS, dibenz(a,h)anthracene and benzo(b)fluoranthene are classified as B2 based on no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting.

As listed in IRIS, the benzo(a)anthracene B2 classification is based on no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. It also produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.*** USEPA determined RfDs for only two of these compounds: pyrene's RfD_o is 0.03 mg/kg-day, and this RfD is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

6.2.6.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Tables 6.2.6.10 and 6.2.6.11 present the computed carcinogenic risk and noncarcinogenic HQs associated with the incidental ingestion and dermal contact with surface soil, respectively.

Future Site Residents

The projected ingestion related ILCR from surface soil was 2E-6, and the dermal pathway risk was 9.0E-7. BEQs were the sole contributors for both pathways. No reference dose is available for BAP, thus no HQs were computed.

Future Site Workers

The projected ingestion related ILCR from surface soil was 2.2E-7, and the dermal pathway risk was 3.7E-7. BEQs were the sole contributor for both pathways. No reference dose is available for BAP, thus no HQs were computed.

Because site worker risk projections did not exceed the most conservative 1E-6 point of departure (assuming that all surface soil was accessible for contact exposure), no formal assessment was necessary considering the influences of current site features. The area in and around SWMU 178 can be characterized as bare ground. A fence currently prevents frequent trespass, and only workers engaged in short-term activities would be likely to enter the area.

COCs Identified

COCs were identified based on soil and groundwater pathway risk and hazard projected for the site. BEQs were the only COCs in SWMU 178 surface soil. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or an HI above 1.0, and whose individual ILCR exceeds 1E-6 or whose HQ exceeds 0.1. For carcinogens, this approach is comparatively conservative, as USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

The soil exposure scenarios were maintained in both instances. Under the traditional risk-based COC trigger provisions, no carcinogenic COCs would be identified under the hypothetical residential use scenario for soil because the cumulative risk is well below 1E-4.

Surface Soil

Hypothetical Site Residents

BEQs were identified as COCs for this scenario based on their contribution to risk/hazard.

Hypothetical Site Workers

No COCs were identified for this scenario based on the sum ILCR and HI.

Due to the limited extent of identified soil impacts, mapping risk projections for SWMU 178 surface soil was of limited use. Instead, the extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential RGOs were compared to each reported concentration for the COCs identified above. RGOs are described in Section 6.2.6.8. RGOs used for this comparison were calculated based on an ILCR of 1E-6. BEQs were reported at concentrations exceeding the corresponding RGO at one sample location, 178SB005 (0.175 mg/kg), which was one of only two locations at which they were identified (two of six surface soil samples). Under an assumed future industrial use, surface soil RGOs were not exceeded at any sampling location.

6.2.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Under current site use conditions, workers are infrequently exposed to surface soil when working within the fence. Because of the location and size of the site, workers would not be expected to work onsite in contact with affected media for a significant portion of the working day, and the frequency of activities in this area is far less than the 250 days per year assumed in the exposure assessment.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current plans call for continued use as nonresidential cargo terminal. If this area becomes residential, surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard to site workers and future site residents. In addition, the size of the site would indicate that the affected area would make up only a portion of the typical backyard exposure area for residents.

Shallow groundwater is not currently used at SWMU 178 for potable or industrial purposes. A basewide system that supplies drinking and process water throughout Zone H is to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The maximum concentration reported for BEQs was used as the EPC for surface soil. As a result, the quantification of exposure does not account for potential variability in the contaminant concentrations in the matrices.

pathway evaluated relative to shallow groundwater. Table 6.2.6.12 summarizes risk for each pathway/receptor group evaluated for SWMU 178.

6.2.6.8 Remedial Goal Options

Soil

RGOs for the hypothetical site residential scenario were calculated for BAP, as shown in Table 6.2.6.13. Inclusion in an RGO table does not necessarily indicate that remedial action is warranted. RGOs are options to be considered when making risk management decisions which, in accordance with RAGS, are not to be included in HHRAs.

Table 6.2.6.1
Methods Run at SWMU 178
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
178	B001	S	S	S	Y					S	Y					
178	B002	S	S	S	Y					S	Y					
178	B003	S	S	S	Y					S	Y					
178	B004	S	S	S	Y					S	Y					
178	B005	S	S	S	Y					S	Y					
178	B006	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbieides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.6.2
Methods Run at SWMU 178
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
178	W001	S	S	S	Y					S	Y					
178	W002	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II:	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.6.3
Methods Run at SWMU 178
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
178	W001	S	S													
178	W002	S	S													

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.6.4
SWMU 178
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	MG/KG	6/ 6		4570.000 - 11000.000	7823.333	7800.0000	3	25310.000	
Antimony	MG/KG	2/ 6	1.50 - 2.10	1.400 - 1.400	1.400	3.1000			
Arsenic	MG/KG	3/ 6	4.60 - 6.70	3.600 - 7.700	5.966	0.3700	3	14.810	
Barium	MG/KG	2/ 6	14.00 - 27.00	11.300 - 40.300	25.800	550.0000		40.330	
* Benzo(a)pyrene Equivalents	UG/KG	6/ 6		82.125 - 175.450	98.412	88.0000	1		
Benzo(a)anthracene	UG/KG	1/ 6	380.00 - 420.00	140.000 - 140.000	140.000				
Benzo(b)fluoranthene	UG/KG	2/ 6	380.00 - 420.00	88.000 - 200.000	144.000				
Chrysene	UG/KG	1/ 6	380.00 - 420.00	150.000 - 150.000	150.000				
Benzo(k)fluoranthene	UG/KG	1/ 6	380.00 - 420.00	130.000 - 130.000	130.000				
Benzo(a)pyrene	UG/KG	1/ 6	380.00 - 420.00	140.000 - 140.000	140.000				
Beryllium	MG/KG	1/ 6	0.18 - 0.36	0.080 - 0.080	0.080	0.1500		1.470	
Calcium	MG/KG	5/ 6	1.00 - 1.00	844.000 - 56600.000	34488.800				
alpha-Chlordane	UG/KG	3/ 6	4.00 - 20.00	2.000 - 3.000	2.333	470.0000			
gamma-Chlordane	UG/KG	3/ 6	4.00 - 20.00	3.000 - 8.000	5.333	470.0000			
Chromium	MG/KG	2/ 6	9.10 - 25.50	7.000 - 14.900	10.950	39.0000		85.650	
Cobalt	MG/KG	1/ 6	1.40 - 2.10	0.680 - 0.680	0.680	470.0000		5.860	
Copper	MG/KG	5/ 6	10.80 - 10.80	0.940 - 15.300	7.848	290.0000		27.600	
4,4'-DDD	UG/KG	1/ 6	7.00 - 40.00	4.000 - 4.000	4.000	2700.0000			
4,4'-DDE	UG/KG	5/ 6	4.00 - 4.00	12.000 - 220.000	66.200	1900.0000			
4,4'-DDT	UG/KG	5/ 6	8.00 - 8.00	9.000 - 93.000	36.600	1900.0000			
Fluoranthene	UG/KG	1/ 6	380.00 - 420.00	270.000 - 270.000	270.000	310000.0000			
Heptachlor epoxide	UG/KG	1/ 6	4.00 - 20.00	3.000 - 3.000	3.000	70.0000			
Iron	MG/KG	6/ 6		4170.000 - 12300.000	8083.333			30910.000	
Lead	MG/KG	1/ 6	17.60 - 89.40	5.500 - 5.500	5.500	400.0000j		118.000	
Magnesium	MG/KG	6/ 6		209.000 - 3860.000	1675.500			9592.000	
Manganese	MG/KG	5/ 6	34.20 - 34.20	12.900 - 66.100	42.660	39.0000	4	636.400	
Phenanthrene	UG/KG	1/ 6	380.00 - 420.00	110.000 - 110.000	110.000	310000.0000k			
Potassium	MG/KG	1/ 6	265.00 - 517.00	502.000 - 502.000	502.000				
Pyrene	UG/KG	2/ 6	380.00 - 420.00	120.000 - 290.000	205.000	230000.0000			
Selenium	MG/KG	2/ 6	0.30 - 0.36	0.470 - 0.930	0.700	39.0000		2.000	
Sodium	MG/KG	5/ 6	170.00 - 170.00	26.100 - 577.000	338.620				
* Petroleum Hydrocarbons, TPH	MG/KG	5/ 6	72.00 - 72.00	140.000 - 900.000	424.000	10.0000	5		
Toluene	UG/KG	6/ 6		3.700 - 11.000	5.683	1600000.0000			
Vanadium	MG/KG	1/ 6	16.30 - 32.70	16.800 - 16.800	16.800	55.0000		77.380	

Table 6.2.6.4
SWMU 178
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Zinc	MG/KG	1/ 6	4.20 - 115.00	160.000 - 160.000	160.000	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.6.5
SWMU 178
Shallow Groundwater - Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	UG/L	1/ 2	15.10 - 15.10	15.500 - 15.500	15.500	3700.0000			
Barium	UG/L	1/ 2	0.90 - 0.90	2.800 - 2.800	2.800	260.0000		323.000	
Calcium	UG/L	2/ 2		37100.000 - 267000.000	152050.000				
Iron	UG/L	2/ 2		301.000 - 365.000	333.000				
Magnesium	UG/L	2/ 2		31400.000 - 65700.000	48550.000				
Manganese	UG/L	2/ 2		13.100 - 158.000	85.550	18.0000	1	3391.000	
Potassium	UG/L	2/ 2		20700.000 - 33800.000	27250.000				
Sodium	UG/L	2/ 2		113000.000 - 259000.000	186000.000				

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.6.8
SWMU 178
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Aluminum	UG/L	1/ 2	14.30 - 14.30	140.350 - 140.350	140.350	3700.0000			
Arsenic	UG/L	1/ 2	2.70 - 2.70	4.900 - 4.900	4.900	0.0380	1	27.990	
Barium	UG/L	1/ 2	15.20 - 15.20	4.700 - 4.700	4.700	260.0000		323.000	
Calcium	UG/L	2/ 2		32600.000 - 66900.000	49750.000				
Chromium	UG/L	1/ 2	3.10 - 3.10	2.700 - 2.700	2.700	18.0000			
Iron	UG/L	2/ 2		352.000 - 989.000	670.500				
Magnesium	UG/L	2/ 2		30750.000 - 108000.000	69375.000				
Manganese	UG/L	2/ 2		12.600 - 19.750	16.175	18.0000	1	3391.000	
Nickel	UG/L	1/ 2	8.60 - 8.60	6.900 - 6.900	6.900	73.0000			
Potassium	UG/L	2/ 2		18950.000 - 64550.000	41750.000				
Sodium	UG/L	2/ 2		132000.000 - 841500.000	486750.000				
Vanadium	UG/L	1/ 2	4.80 - 4.80	4.500 - 4.500	4.500	26.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.6.7
Exposure Pathways Summary — SWMU 178
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for SWMU 178, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 178.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 178.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for SWMU 178, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Risk-based screening was performed on shallow groundwater data. No COPCs were identified at this site. Therefore, shallow groundwater was not addressed formally.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Risk-based screening was performed on shallow groundwater data. No VOCs were identified as shallow groundwater COPCs at this site.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.

Table 6.2.6.7
Exposure Pathways Summary — SWMU 178
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.6.8
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 178
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene equivalents	1	0.175	2.40E-07	2.24E-06	2.75E-07	8.58E-08	3.07E-08

NOTES:

TEF	toxic equivalency factor relative to Benzo(a)pyrene
lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk

Table 6.2.6.9
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 178
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene equivalents	1	0.175	0.01	9.85E-08	3.25E-07	6.17E-08	7.04E-08	2.51E-08

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.6.10
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 178
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	2.0E-06	ND	2.2E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.6.11
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 178
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	9.0E-07	ND	3.7E-07

NOTES:

- NA Not available
- ND Not Determined due to lack of available information
- lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
- ILCR Incremental Lifetime excess Cancer Risk
- \- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.6.12
Summary of Risk and Hazard for SWMU 178
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	2E-06	ND	2E-07
	Dermal Contact	ND	ND	8E-07	ND	3E-07
Sum of All Pathways		ND	ND	2E-06	ND	5E-07

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 6.2.6.13
Residential-Based Remedial Goal Options
Naval Base Charleston, SWMU 178 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	**Hazard-Based Remedial Goal Options** **10** mg/kg	**1** mg/kg	**0.1** mg/kg	**Risk-Based Remedial Goal Options** **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Benzo(a)pyrene equivalents	7.3	NA	0.175	ND	ND	ND	0.060	0.60	6.0	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Frequency of Detection and Spatial Distribution

The use of the maximum concentration as an EPC is questionable for the COCs at this site, and the calculated risk and hazard could be skewed up or down because of the low frequency of detection. The biased sampling approach would tend to skew exposure estimates high.

BEQs reported in surface soil at SWMU 178 deserves further mention due to the fact that they were detected in only two of six samples. The BEQ at only one location exceeded the residential RBC. As a result, the potential for chronic exposure at the EPC is considered low. Therefore, risk projected in this assessment is considered an overestimate. The only BEQ hits were J-qualified; therefore, confidence in the quantitation is relatively low. If frequency of detection were used to estimate the FI from contaminated source and FC from contaminated source terms, no COCs would be identified for SWMU 178 because the residential ILCR (incidental ingestion and dermal contact) would not exceed 1E-6.

Elevated TPH results (140 to 900 mg/kg) were reported in soil onsite. No groundwater sample contained detectable concentrations of TPH, indicating that the shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of TPH constituents.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of aluminum, arsenic, and manganese exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding reference concentrations. Because they did not contribute to excess risk/hazard at the site, they were eliminated from formal assessment based on comparisons to the reference concentrations.

The sample in which BAP was detected was collected directly beneath an asphalt covered lot. BAP is a constituent of asphalt and its presence is not necessarily attributable to past or current site operation.

Both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard. An individual map was not produced for this site.

The CT assumption for residential exposure duration is nine years compared to the 30-year assumption for RME. If all other exposure assumptions remain fixed, application of the CT exposure duration would result in risk projections 66% below the RME presented in Table 6.2.6.10 and 6.2.6.11. At CT, the surface soil-related risk (incidental ingestion and dermal contact) would fall below the 1E-6 point of departure.

6.2.6.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 178 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion was the sole

6.2.4 Baseline Risk Assessment for SWMU 17

6.2.4.1 Site Background and Investigative Approach

SWMU 17 was investigated to assess soil and groundwater potentially affected by site activities. SWMU 17 is designated as such because of a 1987 release of 14,000 gallons of No. 5 fuel oil from a ruptured fuel pipe beneath Building FBM 61. PCBs were also reported in the soil near SWMU 17; a nearby transformer was thought to be the source.

Thirty-three surface soil samples (0 to 1 foot deep) were collected during the RFI. Table 6.2.4.1 lists each surface soil designation and the methods used to analyze them. Samples were collected from six shallow monitoring wells during two quarterly monitoring events. Tables 6.2.4.2 and 6.2.4.3 list the analytical methods.

6.2.4.2 COPC Identification

Soil

Based on the screening comparisons described earlier and presented in Table 6.2.4.4, this HHRA focused on the following surface soil COPCs: antimony, cadmium, BEQs, and PCB Aroclor-1260. Wilcoxon rank sum test results indicate that antimony is not significantly higher than background in upper level soil at SWMU 17. In this case, the Wilcoxon test is less powerful than usual because antimony nondetects exceed 90% for both site and background datasets. Due to similarities in chemical-structure and toxicological characteristics, Aroclor-1254 was considered for retention in the formal assessment along with Aroclor-1260, which exceeded its residential soil RBC. Aroclor-1254 was, however, present in only one of 33 surface soil samples at concentrations above soil ALs. As a result of the frequency of detection and the low concentration reported, Aroclor-1254 was not retained for formal assessment.

Petroleum hydrocarbons (TPH) were identified in six of 11 surface soil samples analyzed at concentrations ranging between 100 and 1,200 mg/kg. These concentrations exceed the soil AL of 100 mg/kg established for NAVBASE. Indeterminate lubricating oil was also present in six of seven samples at concentrations ranging from 12 to 120 mg/kg.

Groundwater

As shown in Table 6.2.4.5, the COPCs identified in first-quarter shallow groundwater were: benzidine, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. As shown in Table 6.2.4.6, second-quarter COPCs were the same with the addition of chlorobenzene, and chromium added. SWMU 17 has no deep groundwater monitoring wells.

During third-quarter sampling at SWMU 17, monitoring well 017MW002 reportedly contained free product. The free product was characterized as a viscous, oily mass which adhered to the bailer. The analytical laboratory was instructed to analyze the free-product phase separately. The results for third-quarter groundwater samples at SWMU 17 have not been compiled to date. These data will be presented in a subsequent groundwater monitoring report for Zone H, and should be considered during risk management decision-making.

6.2.4.3 Exposure Assessment

Exposure Setting

The exposure setting at SWMU 17, referred to as the Oil Spill Area (Building 61) in the RFA, is an industrial area where the groundwater is not used for any purpose.

The building is used infrequently as office space and classrooms. Surface soil is partially covered by pavement and buildings, and current exposure to surface soil is minimal. SWMU 17 area is scheduled to become a marine cargo terminal, according to current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed in this risk assessment. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions and the use of shallow groundwater as a potable water source. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact and the fact that groundwater is not currently used onsite as a source of potable or process water. Therefore, future worker assessment is considered protective of current site users. The future site resident scenario was built on the premise that buildings would be removed and replaced with dwellings. In addition, the future site residents were assumed to use the shallow aquifer onsite for drinking water.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of surface soil and ingestion and inhalation of contaminants identified in groundwater. The exposure pathways for future residential land use are the same as those for the future site worker. In addition, the hypothetical future site worker would be continuously exposed to surface soil and groundwater. Uniform exposure was assumed for all sample locations unless otherwise mentioned. Table 6.2.4.7 justifies exposure pathways assessed in this HHRA.

Exposure Point Concentration

As discussed in Section 6.1.4.4, UCLs were calculated for datasets with at least 10 samples. As shown in Table 6.2.4.8, UCLs were calculated for surface soil COPCs. There were no more than six samples in any dataset for groundwater COPCs. Because current groundwater data (first and second quarter) may not fully account for temporal variability, it was not considered appropriate to establish EPCs based on mean values for the two quarterly events. As a result, the maximum COPC concentration reported during either quarter was applied as the shallow groundwater EPC.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with surface soil are shown in Tables 6.2.4.9 and 6.2.4.10.

Groundwater

The CDIs for groundwater ingestion/inhalation are presented in Table 6.2.4.11.

6.2.4.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.5 of this report. Table 6.2.4.12 presents toxicological information specific to each COPC identified at SWMU 17. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each SWMU COPC are provided in the following paragraphs.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), BAP is classified as a B2 carcinogen due to insufficient data. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified (see Additional Comments for Oral Exposure). This section provides information on three aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μ/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the B2 classification for dibenz(a,h)anthracene, benzo(a)anthracene, benzo(b)fluoranthene, and benzo(k)flouranthene is based on no human data but sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene***. USEPA determined RfDs for only two of these compounds: pyrene's RfD_o of 0.03 mg/kg-day is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene is 0.06 mg/kg-day.

PCB Aroclors are a group of chlorinated hydrocarbons (such as ***Aroclor-1248, 1254, and 1260***) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme concentrations, rashes, chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen et al., 1986; Dreisbach, et al., 1987). USEPA classified PCB Aroclors as group B2 carcinogens, primarily based on animal data. As listed in IRIS (search date 6/29/95), the classification is based on hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate yet suggestive evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. USEPA set 7.7 $(mg/kg\text{-}day)^{-1}$ as the SF_o for PCB Aroclors, and oral RfDs have been set at 0.00007 mg/kg-day for Aroclor-1016 and 0.00002 mg/kg-day for Aroclor-1254.

Benzidine has been identified by USEPA as a group A carcinogen. This compound can cause bladder irritation and is a sensitizer. As listed in IRIS (search date 6/28/95), the classification is based on observation of increased incidence of bladder cancer and bladder cancer-related deaths in exposed workers. The SF_o for benzidine is 230 $(mg/kg\text{-}day)^{-1}$, and the RfD_o is 0.003 mg/kg-day. As listed in IRIS, the critical effect of this chemical is brain cell vacuolization and liver cell alteration in females. The uncertainty factor was 1,000 and the modifying factor was 1 (Dreisbach et al., 1987).

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract. Another target is the blood, where antimony concentrates. Due to frequent industrial use, the primary exposure route for antimony to the general population is food. Antimony is also a common air pollutant from industrial emissions (Klaassen et al., 1986). USEPA has not classified antimony as a carcinogen, and the RfD_o is 0.0004 mg/kg-day. As listed in IRIS (search date 6/28/95), the critical effect of this chemical is longevity, blood glucose, and cholesterol. The uncertainty factor was 1,000 and the modifying factor was 1.

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has caused kidney damage (including kidney stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system (Klaassen et al., 1986). An oral RfD of 0.001 (mg/kg-day) has been determined by USEPA, based on human studies (food) involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for water has been determined by USEPA to be 0.0005 mg/kg-day. For inhalation exposure, cadmium has been classified by

USEPA as a group B1, or probable human carcinogen, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. As listed in IRIS, (search date 6/28/95) the classification is based on limited evidence from occupational epidemiologic studies of cadmium which were consistent across investigations and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven rat and mice studies where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route. As listed in IRIS, the critical effect of this chemical in water is significant proteinuria. The uncertainty factor was 10 and the modifying factor was 1.

1,2-Dichlorobenzene is a CLP SVOC; however, it was evaluated for the inhalation pathway as a volatile due to its Henry's Law Constant (a measure of its likelihood to volatilize at a given temperature). This compound affects the CNS, damages liver and kidney, and irritates mucous membranes, skin, and eyes (Dreisbach et al., 1987). USEPA set the RfD_o and RfD_i to 0.09 and 0.0571 mg/kg-day, respectively.

1,3-Dichlorobenzene is a CLP SVOC; however, it was evaluated for the inhalation pathway as a volatile due to its Henry's law constant. This compound likely affects the CNS based on structural similarities to the other analogues addressed in this risk assessment (Dreisbach et al., 1987). 1,3-Dichlorobenzene could damage liver and kidney, and irritates mucous membranes, skin, and eyes. USEPA set the RfD_o to 0.089 mg/kg-day.

1,4-Dichlorobenzene is a CLP SVOC; however, it was evaluated for the inhalation pathway as a volatile due to its Henry's law constant. This compound affects the CNS, damages liver and kidney, and irritates mucous membranes, skin, and eyes (Dreisbach et al., 1987). This compound is classified by USEPA as a B2 carcinogen, with a SF_o of 0.024 $(mg/kg\text{-}day)^{-1}$. The RfD_i was set to 0.229 mg/kg-day. As listed in IRIS (search date 6/29/95), the critical effect of this chemical is increased liver weights in P1 males. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfC is 0.8 mg/m^3.

1,2,4-Trichlorobenzene is a CLP semivolatile organic compound; however, it was evaluated for the inhalation pathway as a volatile due to its Henry's law constant. This compound affects the CNS, damages liver and kidney and irritates mucous membranes, skin, and eyes (Dreisbach et al., 1987). USEPA determined the RfD_o and RfD_i to be 0.01 and 0.00257 mg/kg-day, respectively.

Chlorobenzene, a VOC that affects the CNS, damages liver and kidney, and irritates mucous membranes, skin, and eyes (Dreisbach et al., 1987). As listed in IRIS (search date 6/28/95), for the D classification is based on no human data, inadequate animal data, and predominantly negative genetic toxicity data in bacterial, yeast, and mouse lymphoma cells. USEPA set the RfD_o and RfD_i to 0.02 and 0.00571 mg/kg-day, respectively. As listed in IRIS, the critical effect of this chemical is histopathologic changes in liver. The uncertainty factor was 1,000 and the modifying factor was 1.

Chromium exists in two stable, natural forms: trivalent (CrIII), and hexavalent (CrVI). Acute exposure to chromium can result in kidney damage following oral exposure, or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (Gradient, 1991). Oral RfD values for both forms of chromium are 1.0 and 5E-3 (mg/kg-day), respectively. For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and an SF of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS (search date 6/28/95), no critical effects were observed for chromium (III). The uncertainty factor was determined to be 100 and the modifying factor was determined to be 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor is 500 and the modifying factor is 1.

6.2.4.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 6.2.4.13 and 6.2.4.14 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of site surface soil and dermal contact with it.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for SWMU 17 surface soil is 3E-4. The primary contributor is Aroclor-1260 (2.8E-4). BEQs were the only other contributors to the carcinogenic risk projection. The dermal pathway ILCR is 1E-4, which is also primarily attributable to Aroclor-1260, with BEQs contributing the rest.

The computed HI for the ingestion pathway is 0.007 for the adult resident and 0.07 for the child resident. The dermal contact pathway HI is 0.002 for the adult resident and 0.005 for the child scenario. Antimony and cadmium were the only contributors for each pathway.

Hypothetical Site Workers

Site worker ILCRs are 3E-5 and 5E-5 for the ingestion and dermal contact pathways. The HIs for the ingestion and dermal pathways are 0.003 and 0.001, respectively.

Site worker risk projections exceed the most conservative 1E-6 point of departure assuming that all surface soil is accessible for contact exposure. As a result, the influences of current site features, such as buildings or pavement, on potential exposure were evaluated. The small courtyard area in which surface soil samples 017SB001 through 017SB006 were collected is currently covered by asphalt. As a result, contact with this soil would not be expected if the surface remains intact. These surface soil samples were found to be heavily impacted, with Aroclor-1260 concentrations ranging from nondetect to 23,100 μg/kg.

The maximum surface soil Aroclor-1260 concentration (180,000 μg/kg) was detected in 017SB020. This sample, along with 11 other samples with Aroclor-1260 concentrations above the residential RBC, was collected from an unpaved grassy area jutting into the northeast side of the building. The total unpaved area is approximately 0.75 acre. Although the grass cover reduces casual contact with underlying soil, ingestion and dermal contact pathways remain viable.

The mean concentration of Aroclor-1260 in the unpaved areas slightly exceeded 10,000 μg/kg, which is nearly identical to the overall site average of 9,200 μg/kg. This analysis indicates that the EPC for the unpaved area would not be expected to be less than that of the overall site. An FI/FC factor accounting for the fraction of the site covered with asphalt would be 0.5 or less. The FI/FC would necessarily assume uniform worker activity patterns across the site. The resultant site worker surface soil pathway risk projection would be approximately 4E-5 (ingestion and dermal contact pathways).

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under both residential and industrial scenarios. For these scenarios, the ingestion and inhalation exposure pathways were evaluated assuming the site groundwater will be used for potable and/or domestic purposes, and that an unfiltered well drawing from the affected water-bearing zone will be installed. Tables 6.2.4.15 and 6.2.4.16 present the risk and hazard for the ingestion and inhalation of COPCs in shallow groundwater.

Hypothetical Site Residents

The groundwater ingestion ILCR for hypothetical site residents is 2E-1, and the inhalation pathway ILCR is 4E-4. The calculated ingestion pathway risk is almost exclusively attributable to benzidine with 1,4-dichlorobenzene as a minor contributor. The one-hit ILCR calculation was used for benzidine. 1,4-Dichlorobenzene was the sole contributor to the inhalation pathway ILCR. For the ingestion pathway, the HIs for the adult and child residents are 10 and 24. The inhalation pathway HI is 24 for the adult resident; for the child resident, 55. The primary contributors to the ingestion and inhalation HIs are chlorobenzene and 1,2,4-trichlorobenzene.

Hypothetical Site Workers

The risk posed to future site workers is 6E-2 for the ingestion pathway and 1E-4 for the inhalation pathway. Benzidine was the primary contributor to ingestion pathway ILCR and 1,4-dichlorobenzene was the sole inhalation pathway contributor. The HIs for the ingestion and inhalation exposure pathways of 4 and 8 and were attributable mainly to chlorobenzene and 1,2,4-trichlorobenzene.

Current Site Workers

Shallow groundwater is not currently a potable water source for SWMU 17 or other areas of Zone H. In the absence of a completed exposure pathway, reported shallow groundwater contamination poses no threat to human health.

Benzidine, which contributes by far most of the ingestion-related shallow groundwater risk, was detected exclusively in 017MW005 during first-quarter sampling. This well was installed in the parking lot north of the area in which major soil impacts were identified. Because benzidine is a component of coal tars and asphalt, its presence during the initial sampling round could be associated with sediment entrained in the shallow groundwater during well installation.

1,4-Dichlorobenzene, 1,3-dichlorobenzene, 1,2-dichlorobenzene, chlorobenzene, and 1,2,4-trichlorobenzene were each detected in first- and second-quarter groundwater samples from well 017MW002. Chlorinated benzenes were not detected in any other well installed at SWMU 17. The isolated nature of shallow aquifer impacts for chlorinated benzenes suggests that chronic exposure at concentrations near the EPC are unlikely outside the immediate vicinity of 017MW002.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for SWMU 17. COCs were selected for both surface soil and shallow groundwater. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6 and an HI threshold of 1.0 (unity). In Zone H HHRAs, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a cumulative HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is relatively conservative because USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection algorithm presented was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process. Table 6.2.4.17 presents the COCs identified at SWMU 17 on a medium-specific basis. A multimedia use scenario identifies COCs, as presented in Table 6.2.4.17. This scenario assumes exclusive use of the shallow water-bearing zone for potable or domestic water production.

Surface Soil

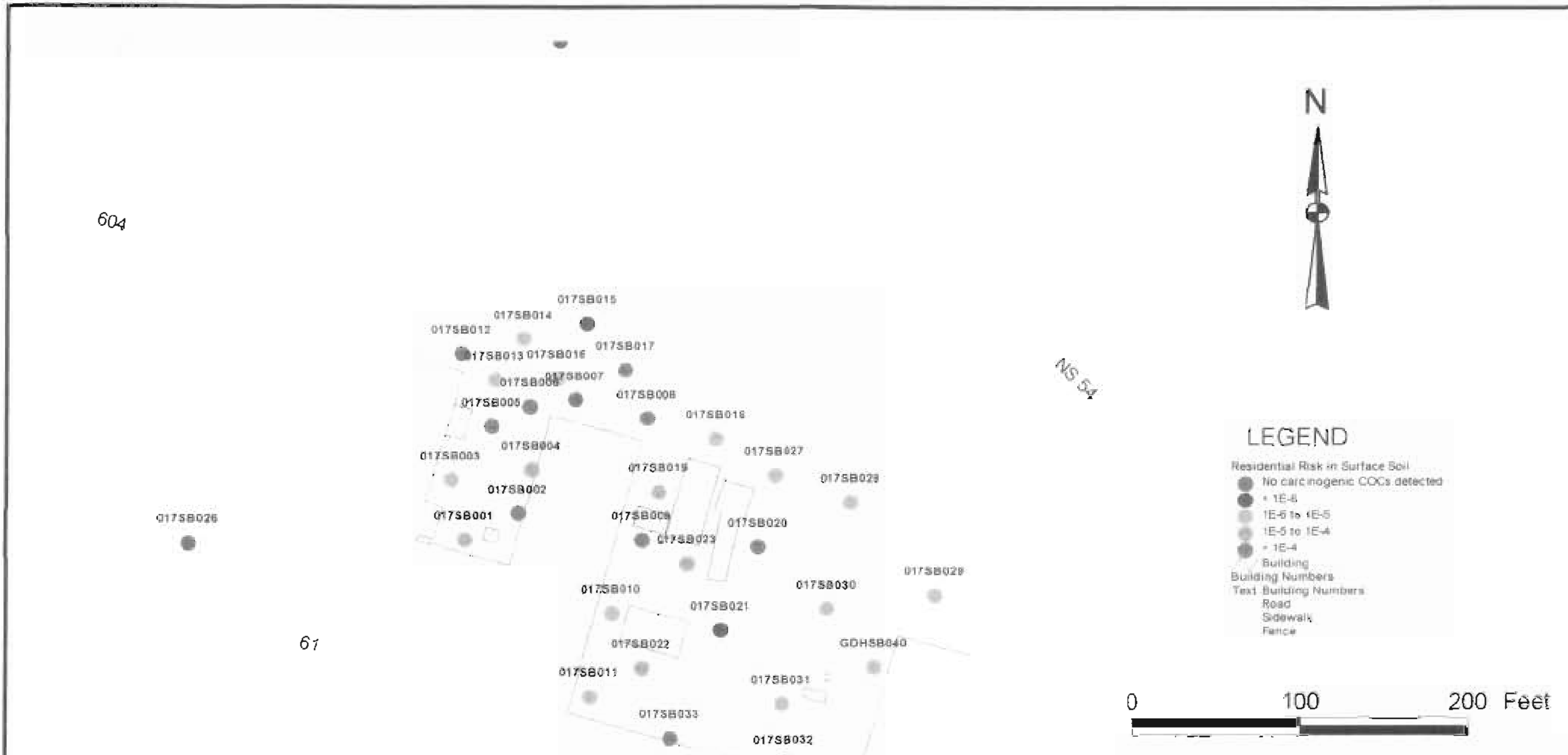
Hypothetical Site Residents

PCB Aroclor-1260 and BEQs were identified as surface soil COCs based on their contribution to ILCR. No hazard-based COCs were identified for the site resident scenario. BEQs were identified as COCs based on the combined ILCR for the ingestion and dermal contact pathways. Carcinogenic PAHs were identified in less than 25% of all surface soil samples analyzed. Figure 6.2.4.1 illustrates calculated risk from surface soil for hypothetical site residents at SWMU 17.

Hypothetical Site Workers

PCB Aroclor-1260 was identified as a COC for surface soil based on its contribution to ILCR. No hazard-based COCs were identified for the site worker scenario. Figure 6.2.4.2 illustrates calculated risk from surface soil for hypothetical site workers at SWMU 17.

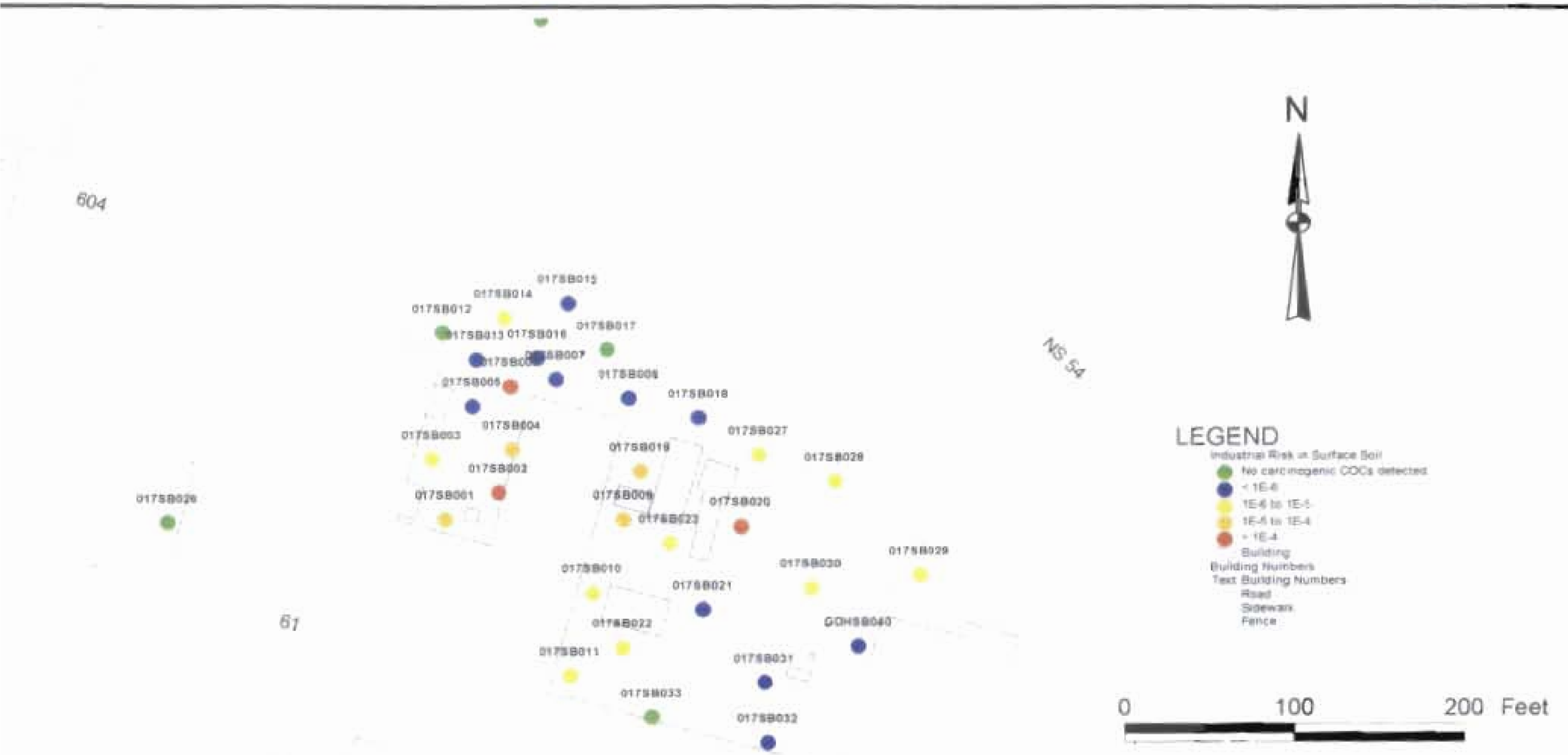
The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential risk-based concentrations were compared to each reported concentration for each COC identified above. PCB Aroclor-1260 was reported above the corresponding RBC (0.057 mg/kg) at 19 sample locations of 33 across SWMU 17. The highest concentrations were reported at sample locations 017SB002, 017SB006, and 017SB020. Aroclor-1260's maximum concentration was reported at location 017SB020 (180,000 μg/kg) which is not covered by asphalt. Twelve of the 19 surface soil samples collected in the unpaved area had Aroclor-1260 concentrations exceeding the residential RBC. Only two of 26 surface soil locations had BEQs concentrations exceeding the residential RBC. Both samples were collected in the unpaved area.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 6.2.4.1
NAVBASE-CHARLESTON ZONE H
SWMU 17 SURFACE SOIL
RESIDENTIAL SCENARIO ILCR

DATE 07/03/98 | PROJ NAME RFI017.APR



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 6.2.4.2
NAVBASE-CHARLESTON ZONE H
SWMU 17 SURFACE SOIL
WORKER SCENARIO ILCR

DATE 07/03/96	PROJ NAME RFI017.APR

Shallow Groundwater

Hypothetical Site Residents

The carcinogenic COCs identified in shallow groundwater are benzidine and 1,4-dichlorobenzene; the COCs based on noncarcinogenic hazard are benzidine, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene.

Hypothetical Site Workers

The carcinogenic COCs identified in shallow groundwater are benzidine and 1,4-dichlorobenzene; the COCs, based on their HQs, are benzidine, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene.

The extent of the COCs identified in shallow groundwater is briefly discussed below. The chlorinated benzene COCs identified in shallow groundwater were reported exclusively in well 017GW002. The results for these compounds were consistent between first- and second-quarter sampling rounds. Benzidine was detected in the first-round sample from 017MW005 only. The absence of this compound in second-round samples brings into question the potential chronicity of exposure. Third- and fourth-quarter results will confirm whether benzidine is present in shallow groundwater. This review will facilitate responsible and sound risk management decisions.

6.2.4.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site groundwater. They are infrequently exposed to surface soil when walking across the site, using commercial facilities, or mowing grass. Site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. Mowing grass 52 days per year would reduce exposure frequency 80% relative to the default site worker assumptions. As a result, estimated exposure would be proportionately reduced.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current base reuse plans indicate that the SWMU 17 area will become a marine cargo terminal and intermodal railyard. If this area was used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard to current site workers and future site residents.

Shallow groundwater is not currently used at SWMU 17 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone H. This system is to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The maximum concentrations (over two quarterly sampling events) were used as the EPCs for each groundwater COC. This EPC application is appropriate for chlorinated benzenes because they were consistently detected during two sampling periods. Over time, a better approximation of chronic exposure may be made based on an evaluation of any temporal variability in their concentrations. Based on the isolated occurrence of this compound group (017MW002 only), the applied chlorinated benzene EPCs account only for risk associated with exposure to shallow groundwater in the immediately vicinity of the impacted well.

Benzidine was detected during first-quarter sampling only. The concentration reported (56 μg/L) was assumed to represent shallow groundwater quality for the entire site. This is not expected to be the case, and third- and fourth-quarter results should be considered in any risk management decisions related to this compound in groundwater.

The 95% UCL concentrations for each soil COC were applied as the EPC. Antimony and BEQs were detected in less than 25% of all surface soil samples. As a result, the confidence in the EPC is reduced.

Frequency of Detection and Spatial Distribution

In surface soil, PCB Aroclor-1260 was detected in 26 of 33 samples. The relatively high frequency of detection of Aroclor-1260 provides greater certainty that computed EPCs represent reasonable estimates. The highest concentrations of Aroclor-1260 were reported at the same location (017SB020). The widespread presence of Aroclor-1260 increases confidence in the projected CDI for this compound based on the UCL.

In groundwater, all chlorinated benzene COPCs were detected in only one sample at one location (i.e., 017GW00201). This fact increases the uncertainty in groundwater risk and hazard calculated in this HHRA. It is highly conservative to assume that the one well identified as a potential concern would be used as a potable water source in this industrial area, yet the extremely small hot spot drives this assessment. The influence of frequency of detection for groundwater COCs likely leads to overestimates of risk and hazard. Moreover, a source well at the location of sample 017GW002 would deplete the chlorinated hydrocarbons; therefore, the hypothetical source strength would diminish over the assumed 30-year exposure period. The detection of benzidine in well 017GW005 during first quarter only indicates that it is limited in areal extent at best. It has been hypothesized that the first-quarter detection represents a well installation artifact associated with entrainment of asphalt particles from the surrounding parking lot. Third- and fourth-quarter analytical results should be considered before risk management decision-making relative to benzidine in shallow groundwater.

Quantification of Risk/Hazard

The uncertainty inherent in risk assessment is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs eliminated from formal assessment because they do not exceed the corresponding RBCs, only chromium and silver were reported at concentrations within approximately 10% of their RBCs, and each of these would result in less than 0.1 HQ at their maximum reported concentrations. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of aluminum, arsenic, beryllium, vanadium, and manganese exceed their corresponding RBCs, but none of the maximum concentrations exceeds the corresponding reference concentration. Because they do not contribute to excess risk/hazard at the site, they were eliminated from formal assessment based on comparisons to the reference concentrations.

CT was not formally assessed for SWMU 17 surface soil, but a simplified approach was taken to assess the potential influences of CT assumptions, nine years for residential exposure duration compared to the 30-year assumption for RME. The CT exposure frequency assumption is 234 days/year compared to 350 days/year RME. If all other exposure assumptions remain fixed, application of the CT exposure duration and frequency would result in risk projections 80% below the RME. At CT, the residential surface soil pathway-related risk (incidental ingestion and dermal contact) would fall below the 1E-4 but would still be considerably higher than the 1E-6 point of departure.

Although the future land use of SWMU 17 is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, it is likely that these scenarios would overestimate risk and/or hazard.

Groundwater

Of the CPSSs eliminated from formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC, reducing the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. The concentration of manganese exceeds its RBC, but not the corresponding reference concentration. Therefore, manganese was eliminated from formal assessment.

The magnitude of isolated shallow groundwater impacts at SWMU 17 renders CT analysis moot, assuming the aquifer is used for potable purposes. This is true particularly in light of preliminary third-quarter sampling information. The presence of free product in a localized area indicates that further action may be warranted. The scope and schedule for action will depend on risk management decisions.

Groundwater is not currently a potable water source onsite, nor is it used on the naval base. Municipal water is readily available. It is highly unlikely that the site will be developed as a residential area and it is unlikely that a potable-use well would be installed there. It is probable that, if residences were constructed onsite and an unfiltered well was installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source. The quality of Zone H groundwater was discussed in Section 3 of this report, and it was concluded that it may not be suitable for potable use.

6.2.4.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 17 were assessed for the hypothetical site worker and the hypothetical future site resident under RME assumptions. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion and inhalation were evaluated for shallow groundwater based on first- and second-quarter groundwater monitoring data. Table 6.2.4.18 presents the risk summary for each pathway/receptor group evaluated for SWMU 17.

6.2.4.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident and adult site worker, as presented in Tables 6.2.4.19 and 6.2.4.20 for surface soil. Calculation of hazard-based RGOs were based on either the hypothetical child resident or the adult site worker, as noted in each of the corresponding tables.

Groundwater

Groundwater RGOs based on site residents and site workers are listed in Tables 6.2.4.21 and 6.2.4.22.

Table 6.2.4.1
Methods Run at SWMU 17
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Opps	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
017	B001	S	S	S	Y					S	Y					
017	B002	S	S	S	Y					S	Y					
017	B003	S	S	S	Y					S	Y					
017	B004	S	S	S	Y					S	Y					
017	B005	S	S	S	Y					S	Y					
017	B006	S	S	S	Y					S	Y					
017	B007	S	S	S	Y					S	Y					
017	B008	S	S	S	Y					S	Y					
017	B009	S	S	S	Y					S	Y					
017	B010	S	S	S	Y					S	Y					
017	B011	S	S	S	Y					S	Y					
017	B012	S	S							S	Y					
017	B013	B	B	A	Y	Y	Y	Y	A	A	B					
017	B014	S	S							S	Y					
017	B015	S	S							S	Y					
017	B016	S	S							S	Y					
017	B017	S	S							S	Y					
017	B018	B	B	A	Y	Y	Y	Y	A	B	B					
017	B019	S	S							S	Y					
017	B020	S	S							S	Y					
017	B021	S	S							S	Y					
017	B022	B	B	A	Y	Y	Y	Y	A	B	B					
017	B023	S	S							S	Y					
017	B024		S							S	Y					
017	B025		S							S	Y					
017	B026		S							S	Y					
017	B027						Y			S						
017	B028						Y			S						
017	B029						Y			S						
017	B030						Y			S						
017	B031						Y			S						
017	B032						Y			S						
017	B033						Y			S						

Table 6.2.4.1
Methods Run at SWMU 17
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
017	B034						Y									
017	B05A													Y	Y	Y
017	B06A													Y	Y	Y

METHODS:

- Metal: TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
- VOA: Volatile Organics: Method 8240
- SVOA: Semi-volatile Organics: Method 8270
- Cn: Cyanide (Soil: Method 9010, Water: Method 9012)
- Hexac: Hexavalent Chromium: Method 7195
- Dioxin: Dioxins: Method 8290
- Oppe: Organophosphate Pesticides: Method 8140
- Herb: Chlorinated Herbicides: Method 8150
- Pest: Chlorinated Pesticides: Method 8080
- Tph: Total Petroleum Hydrocarbons: Method 418.1
- Tph GR: Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
- Tph DR: Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
- Wq I: Wet Chemistry I Parameters
- Wq II Wet Chemistry II Parameters
- Phys: Physical Chemistry Parameters

KEY:

- Y: Analyzed for standard list
- S: Analyzed for parameters on SW-846 list
- A: Analyzed for parameters on Appendix IX list
- B: Analyzed for parameters on both the SW-846 and Appendix IX lists
- Blank value indicates this method of analysis was not performed

Table 6.2.4.2
Methods Run at SWMU 17
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
017	W001	S	S	S	Y					S	Y					
017	W002	S	S	S	Y					S	Y					
017	W003	S	S	S	Y					S	Y					
017	W004	S	S	S	Y					S	Y					
017	W005	B	B	B	Y	Y	Y	Y	A	B						
017	W006	S	S	S	Y					S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.4.3
Methods Run at SWMU 17
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
017	W001	S	S	S												
017	W002	S	S	S												
017	W003	S	S	S												
017	W004	S	S	S												

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.4.4
SWMU 17
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num Over Screen	Reference Conc.	Num Over Ref.
Acetone	UG/KG	6/ 14	10.00 - 34.00	13.000 - 195.000	51.933	780000.0000			
Aluminum	MG/KG	23/ 23		938.000 - 14500.000	8700.782	7800.0000	14	25310.000	
* Antimony	MG/KG	2/ 23	1.10 - 7.60	2.200 - 10.100	6.150	3.1000	1		
Aroclor-1254	UG/KG	1/ 33	33.00 - 40000.00	42.000 - 42.000	42.000	83.0000			
* Aroclor-1260	UG/KG	26/ 33	40.00 - 74.00	36.000 - 180000.000	9225.319	83.0000	19		
Arsenic	MG/KG	20/ 23	1.00 - 2.10	0.900 - 7.900	3.845	0.3700	20	14.810	
Barium	MG/KG	12/ 23	0.08 - 35.90	7.400 - 23.500	14.833	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	1/ 26	333.00 - 780.00	66.700 - 66.700	66.700	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	26/ 26		68.137 - 220.301	77.558	88.0000	2		
Benzo(a)anthracene	UG/KG	4/ 26	333.00 - 780.00	53.700 - 186.000	114.700				
Benzo(b)fluoranthene	UG/KG	4/ 26	333.00 - 780.00	51.600 - 168.000	99.800				
Chrysene	UG/KG	4/ 26	333.00 - 780.00	64.600 - 221.000	125.025				
Indeno(1,2,3-cd)pyrene	UG/KG	1/ 26	333.00 - 780.00	80.800 - 80.800	80.800				
Benzo(k)fluoranthene	UG/KG	1/ 26	333.00 - 780.00	160.000 - 160.000	160.000				
Benzo(a)pyrene	UG/KG	2/ 26	333.00 - 780.00	116.000 - 175.000	145.500				
Benzoic acid	UG/KG	2/ 26	1800.00 - 3900.00	146.000 - 215.000	180.500	31000000.0000			
Beryllium	MG/KG	12/ 23	0.12 - 0.39	0.090 - 0.640	0.269	0.1500	8	1.470	
Butylbenzylphthalate	UG/KG	1/ 26	333.00 - 780.00	130.000 - 130.000	130.000	1600000.0000			
* Cadmium	MG/KG	8/ 23	0.14 - 0.93	0.150 - 4.700	1.235	3.9000	1	1.050	2
Calcium	MG/KG	23/ 23		1320.000 - 347000.000	42721.739				
alpha-Chlordane	UG/KG	2/ 14	1.70 - 410.00	3.400 - 5.100	4.250	470.0000			
gamma-Chlordane	UG/KG	3/ 14	1.70 - 410.00	2.800 - 12.300	9.066	470.0000			
Chromium	MG/KG	23/ 23		5.900 - 34.600	14.934	39.0000		85.650	
Cobalt	MG/KG	11/ 23	0.41 - 3.60	0.690 - 9.800	2.354	470.0000		5.860	1
Copper	MG/KG	6/ 23	0.23 - 23.00	3.000 - 74.100	32.991	290.0000		27.600	3
Cyanide	MG/KG	2/ 14	0.90 - 1.00	1.000 - 3.000	2.000	160.0000			
4,4'-DDD	UG/KG	1/ 14	3.30 - 810.00	2.900 - 2.900	2.900	2700.0000			
4,4'-DDE	UG/KG	4/ 14	3.30 - 85.00	4.600 - 581.000	152.825	1900.0000			
Di-n-butylphthalate	UG/KG	2/ 26	333.00 - 780.00	64.200 - 71.400	67.800	780000.0000			
1,3-Dichlorobenzene	UG/KG	1/ 26	333.00 - 780.00	43.600 - 43.600	43.600	700000.0000			
Dioxin (TCDD TEQ)	PG/G	11/ 11		1.106 - 127.031	17.208	1000.0000			
Endrin	UG/KG	1/ 14	3.30 - 450.00	2.700 - 2.700	2.700	2300.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	11/ 26	333.00 - 780.00	150.000 - 830.000	350.363	46000.0000			
Fluoranthene	UG/KG	4/ 26	333.00 - 780.00	57.800 - 346.000	176.700	310000.0000			

Table 6.2.4.4
SWMU 17
Surface Soil

	Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
*	Indeterminate Deisel Fuel	UG/KG	1/ 1		18000.000 - 18000.000	18000.000	10.0000	1		
*	Indeterminate Lubricating Oil	UG/KG	6/ 7	20000.00 - 20000.00	12000.000 - 120000.000	55083.333	10.0000	6		
	Iron	MG/KG	23/ 23		2280.000 - 17800.000	7686.521			30910.000	
	Lead	MG/KG	20/ 23	9.80 - 25.10	2.200 - 41.000	17.652	400.0000[j]		118.000	
	Magnesium	MG/KG	23/ 23		214.000 - 3790.000	1027.391			9592.000	
	Manganese	MG/KG	21/ 23	10.40 - 11.90	10.700 - 203.000	73.028	39.0000	13	636.400	
	Mercury	MG/KG	14/ 23	0.02 - 0.03	0.020 - 0.660	0.120	2.3000		0.490	1
	Nickel	MG/KG	13/ 23	1.20 - 9.90	1.100 - 18.550	6.319	160.0000		33.380	
	Phenanthrene	UG/KG	2/ 26	333.00 - 780.00	63.100 - 188.000	125.550	310000.0000[k]			
	Potassium	MG/KG	6/ 23	198.00 - 673.00	200.000 - 1050.000	512.666				
	Pyrene	UG/KG	4/ 26	333.00 - 780.00	57.500 - 280.000	155.875	230000.0000			
	Silver	MG/KG	2/ 23	0.18 - 1.60	10.000 - 34.400	22.200	39.0000			
	Sodium	MG/KG	17/ 23	23.50 - 85.90	41.800 - 341.000	163.876				
	2,4,5-T	UG/KG	1/ 3	10.00 - 10.20	7.500 - 7.500	7.500	78000.0000			
*	Petroleum Hydrocarbons, TPH	MG/KG	6/ 11	65.00 - 74.00	100.000 - 1200.000	405.000	10.0000	6		
	Toluene	UG/KG	3/ 14	5.50 - 6.80	4.400 - 9.600	7.600	1600000.0000			
	Trichloroethene	UG/KG	1/ 14	5.00 - 6.80	1.800 - 1.800	1.800	47000.0000			
	Vanadium	MG/KG	23/ 23		4.600 - 61.800	21.989	55.0000	1	77.380	
	Zinc	MG/KG	15/ 23	6.60 - 34.70	3.500 - 267.000	75.600	2300.0000		214.300	1

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.4.7
Exposure Pathways Summary — SWMU 17
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 17.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 17.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	CPSSs were greater than RBC and Reference concentrations.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.

Table 6.2.4.7
Exposure Pathways Summary — SWMU 17
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.4.8
Statistical Analysis of COPCs
Surface Soils at SWMU 17
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Antimony	23	-0.030	0.760	2.241	1.862	10.1	1.86	UCL used	NA	1.86
Aroclor-1260	33	5.470	2.360	4.337	23.486	180	23.49	UCL used	NA	23.49
Benzo(a)pyrene Equivalents	26	4.300	0.270	1.796	0.084	0.2203	0.084	UCL used	1	0.084
Cadmium	23	-1.67	1.15	2.746	0.715	4.7	0.71	UCL used	NA	0.71

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.4.9
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
SWMU 17
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	1.86	2.55E-06	2.38E-05	2.92E-06	9.11E-07	3.25E-07
Aroclor-1260	23.49	3.22E-05	3.00E-04	3.68E-05	1.15E-05	4.10E-06
Benzo(a)pyrene Equivalents	0.084	1.15E-07	1.08E-06	1.32E-07	4.12E-08	1.47E-08
Cadmium	0.71	9.79E-07	9.14E-06	1.12E-06	3.50E-07	1.25E-07

NOTES:

lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 6.2.4.10
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
SWMU 17
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Antimony	1.86	0.001	1.05E-07	3.45E-07	6.55E-08	7.47E-08	2.67E-08
Aroclor-1260	23.49	0.01	1.32E-05	4.35E-05	8.26E-06	9.42E-06	3.36E-06
Benzo(a)pyrene Equivalents	0.084	0.01	4.73E-08	1.56E-07	2.96E-08	3.38E-08	1.21E-08
Cadmium	0.71	0.001	4.02E-08	1.33E-07	2.51E-08	2.87E-08	1.02E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.4.11
Chronic Daily Intakes (CDI)
Ingestion/Inhalation of COPCs in Shallow Groundwater
SWMU 17
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Benzidine	0.056	1.53E-03	3.58E-03	8.44E-04	5.48E-04	2.70E-04
Chlorobenzene	4.75	1.30E-01	3.04E-01	7.16E-02	4.65E-02	2.29E-02
Chromium (trivalent)	0.04	1.10E-03	2.56E-03	6.03E-04	3.91E-04	1.93E-04
1,4-Dichlorobenzene	1.1	3.01E-02	7.03E-02	1.66E-02	1.08E-02	5.29E-03
1,3-Dichlorobenzene	0.75	2.05E-02	4.79E-02	1.13E-02	7.34E-03	3.61E-03
1,2-Dichlorobenzene	0.11	3.01E-03	7.03E-03	1.66E-03	1.08E-03	5.29E-04
1,2,4-Trichlorobenzene	1	2.74E-02	6.39E-02	1.51E-02	9.78E-03	4.81E-03

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

able 6.2.4.12 - SWMU 17
oxicological Database Information
r Chemicals of Potential Concern
AVBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

nemical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation
ntimony	0.0004	a	L	whole body/blood increased	1000	ND				ND
enzidine	0.003	a	M	brain and liver changes	1000	ND				ND
enzo(a)pyrene Equivalents	ND				ND	ND				ND
admium (food)	0.001	a	H	proteinuria	10	ND				ND
admium (water)	0.0005	a	H	proteinuria	10	ND				ND
nlorobenzene	0.02	a	M	liver changes	1000	0.00571	c			10000
nromium	1	a	L	NA	100/10	ND				ND
4-Dichlorobenzene	ND				ND	0.229	a	M	increased liver weight	100
CB Aroclor-1260	ND				ND	ND				ND
2,4-Trichlorobenzene	0.01	a	M	liver and kidney damage	1000	0.00257	a		liver and kidney damage	
3-Dichlorobenzene	0.089	e	NA	NA	ND	ND				ND
2-Dichlorobenzene	0.09	a	M	liver necrosis	1000	0.09	b	M	whole body weight gain	1000

NOTES:

a Integrated Risk Information System (IRIS)
b Health Effects Assessment Summary Tables (HEAST)
c HEAST alternative method
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

ble 6.2.4.12 - SWMU 17
xicological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Carcinogenic Toxicity Data

emical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
timony	ND		ND		D	
nzidine	230	a	235	a	A	bladder cancer
nzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
dmium (food)	ND		6.3	a	B1	lung
dmium (water)	ND		6.3	a	B1	lung
lorobenzene	ND		ND		D	
romium	ND		42	a	D	
-Dichlorobenzene	0.024	b	ND		B2	NA
B Aroclor-1260	7.7		ND		B2	hepatocellular carcinoma
,4-Trichlorobenzene	ND		ND		D	
-Dichlorobenzene	ND		ND		D	
-Dichlorobenzene	ND		ND		D	

Table 6.2.4.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 17
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.0004	NA	0.0064	0.0595	ND	0.0023	ND
Aroclor-1260	NA	7.7	ND	ND	2.8E-04	ND	3.2E-05
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	9.6E-07	ND	1.1E-07
Cadmium	0.001	NA	0.0010	0.0091	ND	0.0003	ND
SUM Hazard Index/ILCR			0.007	0.07	3E-04	0.003	3E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.4.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 17
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Antimony	0.2	8E-05	NA	0.0013	0.0043	ND	0.0009	ND
Aroclor-1260	0.5	NA	15.4	ND	ND	1.3E-04	ND	5.2E-05
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	4.3E-07	ND	1.8E-07
Cadmium	0.2	0.0002	NA	0.0002	0.0007	ND	0.0001	ND
SUM Hazard Index/ILCR				0.002	0.005	1E-04	0.0011	5E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.4.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
SWMU 17
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzidine	0.003	230	0.5	1.2	1.8E-01	0.2	6.0E-02
Chlorobenzene	0.02	ND	6.5	15.2	ND	2.3	ND
Chromium (trivalent)	1	ND	0.001	0.003	ND	0.0004	ND
1,4-Dichlorobenzene	0.229	0.024	0.1	0.3	4.0E-04	0.05	1.3E-04
1,3-Dichlorobenzene	0.089	ND	0.2	0.5	ND	0.1	ND
1,2-Dichlorobenzene	0.09	ND	0.03	0.1	ND	0.01	ND
1,2,4-Trichlorobenzene	0.01	ND	2.7	6.4	ND	1.0	ND
SUM Hazard Index/ILCR			10	24	2E-01	4	6E-02

NOTES:

- ILCR for benzidine was estimated using one-hit calculation from RAGS

NA Not available

ND Not Determined due to lack of available information

lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A

ILCR Incremental Lifetime excess Cancer Risk

The inhalation RfD for 1,4-dichlorobenzene was applied as a surrogate oral RfD.

Table 6.2.4.16
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater
SWMU 17
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Chlorobenzene	0.00571	ND	22.8	53.2	ND	8.1	ND
1,4-Dichlorobenzene	0.229	0.024	0.1	0.3	4.0E-04	0.05	1.3E-04
1,3-Dichlorobenzene	0.089	ND	0.2	0.5	ND	0.08	ND
1,2-Dichlorobenzene	0.04	ND	0.08	0.18	ND	0.03	ND
1,2,4-Trichlorobenzene	0.0571	ND	0.48	1.12	ND	0.17	ND
SUM Hazard Index/ILCR			24	55	4E-04	8	1E-04

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk

[redacted]

Acetone	UG/L	1/ 6	25.00 -	630.00	17.900 -	17.900	17.900	370.0000		
Aluminum	UG/L	3/ 6	15.10 -	33.70	35.800 -	522.000	205.866	3700.0000		
Barium	UG/L	3/ 6	0.90 -	28.50	6.400 -	15.300	10.966	260.0000		323.000
* Benzidine	UG/L	1/ 6	50.00 -	380.00	56.000 -	56.000	56.000	0.0003	1	
Calcium	UG/L	6/ 6			81700.000 -	179000.000	125716.666			
Chlorobenzene	UG/L	1/ 6	5.00 -	5100.00	2.800 -	2.800	2.800	3.9000		
Copper	UG/L	1/ 6	2.60 -	2.90	3.000 -	3.000	3.000	140.0000		
Di-n-butylphthalate	UG/L	2/ 6	10.00 -	77.00	2.800 -	3.200	3.000	370.0000		
* 1,4-Dichlorobenzene	UG/L	1/ 6	10.00 -	13.00	1100.000 -	1100.000	1100.000	0.4400	1	
* 1,3-Dichlorobenzene	UG/L	1/ 6	10.00 -	13.00	750.000 -	750.000	750.000	54.0000	1	
* 1,2-Dichlorobenzene	UG/L	1/ 6	10.00 -	13.00	110.000 -	110.000	110.000	37.0000	1	
bis(2-Ethylhexyl)phthalate	UG/L	2/ 6	10.00 -	77.00	3.300 -	4.000	3.650	4.8000		
Iron	UG/L	6/ 6			987.000 -	7320.000	2869.500			
Magnesium	UG/L	6/ 6			10100.000 -	156000.000	62166.666			
Manganese	UG/L	6/ 6			73.300 -	630.000	327.683	18.0000	6	3391.000
2-Methylnaphthalene	UG/L	1/ 6	10.00 -	77.00	4.000 -	4.000	4.000	150.0000i		
Naphthalene	UG/L	1/ 6	10.00 -	77.00	6.100 -	6.100	6.100	150.0000		
Potassium	UG/L	6/ 6			8490.000 -	63800.000	32298.333			
Sodium	UG/L	6/ 6			10900.000 -	1340000.000	519666.666			
* 1,2,4-Trichlorobenzene	UG/L	1/ 6	10.00 -	13.00	1000.000 -	1000.000	1000.000	19.0000	1	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- i Naphthalene used as surrogate

[redacted]

	Aluminum	UG/L	1/ 4	15.40 -	15.40	33.700 -	33.700	33.700	3700.0000			
	Arsenic	UG/L	2/ 4	2.60 -	2.60	3.200 -	4.900	4.050	0.0380	2	27.990	
	Barium	UG/L	4/ 4			2.900 -	19.100	13.900	260.0000		323.000	
	Calcium	UG/L	4/ 4			53900.000 -	134000.000	102225.000				
*	Chlorobenzene	UG/L	2/ 4	5.00 -	5.00	3.900 -	4750.000	2376.950	3.9000	2		
*	Chromium	UG/L	1/ 4	2.00 -	2.00	40.000 -	40.000	40.000	18.0000	1		
	Cobalt	UG/L	1/ 4	2.40 -	2.40	2.700 -	2.700	2.700	220.0000			
*	1,4-Dichlorobenzene	UG/L	1/ 4	11.00 -	11.00	830.000 -	830.000	830.000	0.4400	1		
*	1,3-Dichlorobenzene	UG/L	1/ 4	11.00 -	11.00	550.000 -	550.000	550.000	54.0000	1		
*	1,2-Dichlorobenzene	UG/L	1/ 4	11.00 -	11.00	54.500 -	54.500	54.500	37.0000	1		
	Iron	UG/L	4/ 4			1475.000 -	3860.000	2431.250				
	Magnesium	UG/L	4/ 4			13500.000 -	45700.000	30425.000				
	Manganese	UG/L	4/ 4			86.200 -	896.000	448.550	18.0000	4	3391.000	
	Potassium	UG/L	4/ 4			9690.000 -	17200.000	13835.000				
	Selenium	UG/L	1/ 4	3.20 -	3.50	3.900 -	3.900	3.900	18.0000		3.150	1
	Sodium	UG/L	4/ 4			23200.000 -	292000.000	149550.000				
*	1,2,4-Trichlorobenzene	UG/L	1/ 4	11.00 -	11.00	520.000 -	520.000	520.000	19.0000	1		
	2,4,5-Trichlorophenol	UG/L	1/ 4	56.00 -	57.00	19.000 -	19.000	19.000	370.0000			
	Vanadium	UG/L	1/ 4	2.50 -	2.50	3.400 -	3.400	3.400	26.0000			
	Zinc	UG/L	1/ 4	8.00 -	9.20	25.000 -	25.000	25.000	1100.0000			

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.4.17
Summary of Risk and Hazard-based COCs for SWMU 17
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs			
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equiv.	ND	ND	9.6E-07	ND	1.1E-07		2		
		Aroclor-1260	ND	ND	2.8E-04	ND	3.2E-05		2		4
	Dermal Contact	Benzo(a)pyrene Equiv.	ND	ND	4.3E-07	ND	1.8E-07		2		
		Aroclor-1260	ND	ND	1.3E-04	ND	5.2E-05		2		4
Surface Soil Pathway Sum			ND	ND	4E-04	ND	8E-05				
Shallow Groundwat	Ingestion	Benzidine	0.5	1.2	1.8E-01	0.2	6.0E-02	1	2	3	4
		Chlorobenzene	6.5	15.2	ND	2.3	ND	1		3	
		1,4-Dichlorobenzene	0.1	0.3	4.0E-04	0.05	1.3E-04	1	2		4
		1,3-Dichlorobenzene	0.2	0.5	ND	0.1	ND	1			
		1,2-Dichlorobenzene	0.03	0.1	ND	0.01	ND				
		1,2,4-Trichlorobenzene	2.7	6.4	ND	1	ND	1		3	
	Inhalation	Chlorobenzene	22.8	53.2	ND	8.1	ND	1		3	
		1,4-Dichlorobenzene	0.1	0.3	4.0E-04	0.05	1.3E-04	1	2		4
		1,3-Dichlorobenzene	0.2	0.5	ND	0.08	ND	1			
		1,2-Dichlorobenzene	0.08	0.2	ND	0.03	ND	1			
		1,2,4-Trichlorobenzene	0.48	1.1	ND	0.17	ND	1		3	
Shallow Groundwater Pathway Sum			34	79	2E-01	12	6E-02				
Sum of All Pathways			34	79	2E-01	12	6E-02				

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.
Benzo(a)pyrene equivalents were identified as COCs for surface soil based on combined ingestion and dermal contact pathway risk.

Table 6.2.4.18
Summary of Risk and Hazard for SWMU 17
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR
Surface Soil	Incidental Ingestion	0.007	0.07	3E-04	0.003	3E-05
	Dermal Contact	0.002	0.005	1E-04	0.001	5E-05
Shallow Groundwater	Ingestion	10	24	2E-01	4	6E-02
	Inhalation	24	55	4E-04	8	1E-04
Sum of All Pathways		34	79	2E-01	12	6E-02

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 6.2.4.21
Residential-Based Remedial Goal Options
Naval Base Charleston, SWMU 17 Shallow Groundwater
Charleston, South Carolina

Chemical	Oral SF (mg/kg-day)-1	Inh. SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	Inh RfD (mg/kg-day)	Unadj. EPC mg/l	Hazard-Based Remedial Goal Option 0.1 mg/l	Hazard-Based Remedial Goal Option 1.0 mg/l	Hazard-Based Remedial Goal Option 3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	Risk-Based Remedial Goal Options 1E-05 mg/l	Risk-Based Remedial Goal Options 1E-04 mg/l	MCL mg/l	Background Concentration mg/l
Benzidine	230	235	0.003	NA	0.056	0.005	0.05	0.1	3.2E-07	3.2E-06	3.2E-05	NA	NA
Chlorobenzene	NA	NA	0.02	0.00571	4.75	0.007	0.07	0.2	ND	ND	ND	0.1	NA
Chromium (trivalent)	NA	NA	1	NA	0.04	1.6	15.6	46.9	ND	ND	ND	0.1	NA
1,4-Dichlorobenzene	0.024	0.024	0.229	0.229	1.1	0.18	1.8	5.4	0.0014	0.014	0.14	0.075	NA
1,3-Dichlorobenzene	NA	NA	0.089	0.089	0.75	0.070	0.7	2.1	ND	ND	ND	0.6	NA
1,2-Dichlorobenzene	NA	NA	0.09	0.04	0.11	0.04	0.4	1.3	ND	ND	ND	0.6	NA
1,2,4-Trichlorobenzene	NA	NA	0.01	0.0571	1	0.01	0.13	0.4	ND	ND	ND	0.07	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.4.22
Worker-Based Remedial Goal Options
Naval Base Charleston, SWMU 17 Shallow Groundwater
Charleston, South Carolina

Chemical	Oral SF (mg/kg-day)-1	Inh. SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	Inh RfD (mg/kg-day)	Unadj. EPC mg/l	Hazard-Based Remedial Goal Option 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
Benzidine	230	235	0.003	NA	0.056	0.03	0.31	0.92	9.3E-07	9.3E-06	9.3E-05	NA	NA
Chlorobenzene	NA	NA	0.02	0.00571	4.75	0.045	0.45	4.54	ND	ND	ND	0.1	NA
Chromium (trivalent)	NA	NA	1	NA	0.04	10.2	102.2	1022	ND	ND	ND	0.1	NA
1,4-Dichlorobenzene	0.024	0.024	0.229	0.229	1.1	1.17	11.7	117	0.0043	0.0	0.4328	0.075	NA
1,3-Dichlorobenzene	NA	NA	0.089	0.089	0.75	0.45	4.5	45	ND	ND	ND	0.6	NA
1,2-Dichlorobenzene	NA	NA	0.09	0.04	0.11	0.28	2.8	28.3	ND	ND	ND	0.6	NA
1,2,4-Trichlorobenzene	NA	NA	0.01	0.0571	1	0.09	0.9	8.7	ND	ND	ND	0.07	NA

NOTES:
- EPC exposure point concentration
- NA not applicable
- ND not determined

Table 6.2.4.19
Residential-Based Remedial Goal Options
Naval Base Charleston, SWMU 17 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aroclor-1260	7.7	NA	23.49	0.057	0.57	5.72	ND
Benzo(a)pyrene Equivalents	7.3	1	0.084	0.060	0.60	6.04	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.4.20
Worker-Based Remedial Goal Options
Naval Base Charleston, SWMU 17 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aroclor-1260	7.7	NA	23.49	0.28	2.8	28	ND
Benzo(a)pyrene Equivalents	7.3	1	0.084	0.30	3.0	30	ND

NOTES:

TEF toxicity equivalency factor for dioxin congeners; used to adjust EPC to 2,3,7,8-TCDD equivalents
EPC exposure point concentration
NA not applicable
ND not determined

6.2.7 Baseline Risk Assessment for AOC 653

6.2.7.1 Site Background and Investigative Approach

AOC 653 was investigated to assess a hydraulic lift oil storage tank which is no longer in use due to suspected leakage. The hydraulic storage tank is at the west end of Building 1508, one of four main buildings that make up the automotive hobby shop complex. Other buildings in the complex include 636, 1347, 1493, 1508, 1763, and several other structures. Various paints, solvents, thinners, and petroleum products have been used and stored onsite. The July 31, 1991, Zone Inspection Report for Zone 22 stated that the hydraulic storage tank may have leaked, and that spilled waste oil and petroleum hydrocarbons have impacted the site.

Seven soil samples were collected from the surface interval (0 to 1 foot deep). Table 6.2.7.1 shows each surface soil designation and lists of analytical methods. Samples were collected from two shallow monitoring wells; Tables 6.2.7.2 and 6.2.7.3 list the analytical methods for groundwater samples.

6.2.7.2 COPC Identification

Soil

Based on the screening comparisons described in Section 6.1.3.4 of this report and shown in Table 6.2.7.4, this HHRA focuses on the COPCs Aroclor-1248, BAP, and lead. Results of the Wilcoxon rank sum test indicate with more than 99% confidence that the lead samples as a group are significantly higher than background in surface soil at AOC 653. Due to similarities in chemical structure and toxicological characteristics, Aroclor-1260 was retained for formal assessment with Aroclor-1248, which exceeded its residential soil RBC. TPH was identified in four surface soil samples at concentrations ranging between 730 and 36,500 mg/kg. These concentrations exceed the NAVBASE AL of 100 mg/kg.

Groundwater

As shown in Table 6.2.7.5, no COPCs were identified in shallow groundwater relative to first-quarter sample data. Second-quarter results presented in Table 6.2.7.6 indicate that arsenic was present in one of two samples at a concentration exceeding the tap water RBC and the background reference concentration. Wilcoxon rank sum test results indicated that there was no significant difference between group sample concentrations at AOC 653 and background levels in shallow groundwater for any inorganic constituent. As a result, arsenic was the sole shallow groundwater COPC.

6.2.7.3 Exposure Assessment

Exposure Setting

The exposure setting at AOC 653 is the ground around a hydraulic lift oil storage tank with a reported history of leakage. The AOC consists of Building 1508 and the area immediately adjacent. The site is in the northernmost corner of Zone H, near the Cooper River.

The future use of the site is not definite; however, it is anticipated to remain commercial/industrial. AOC 653 is within an area proposed to become a marine cargo terminal in current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed in this risk assessment. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact. Therefore, future worker assessment is considered protective of current site users.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of surface soil. The exposure pathways for future residential land use are the same as those for the future site worker. In addition, the hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Uniform exposure was assumed for all sample locations. Shallow groundwater exposure was assessed relative to ingestion through potable use. No inhalation pathway was analyzed because no volatile COPCs were identified in shallow groundwater. Table 6.2.7.7 justifies exposure pathways assessed in this HHRA.

Exposure Point Concentration

At AOC 653, fewer than 10 surface soil and shallow groundwater samples were collected during the RFI. As a result, the maximum concentration of each COPC was used as the EPC for the corresponding medium. Aroclor-1248, Aroclor-1260, and BEQs were detected in only one of seven surface soil samples collected (653SB001-01). Samples from around 653SB001 did not contain any detectable concentrations of these COPCs. As a result, it was deemed appropriate to derive an FI/FC accounting for the limited areal extent of the surface soil contaminants. This factor was conservatively estimated to be 0.2 indicating that the maximum concentrations reported were representative of soil quality of 20% of the potential exposure area. This factor was used to adjust the EPC for these COPCs. Lead was detected in each surface soil sample and thus, no FI/FC was established for this COPC. Due to the limited dataset available for groundwater, the EPC was not modified.

Quantification of Exposure

Tables 6.2.7.8 and 6.2.7.9 present the CDIs for the ingestion and dermal soil contact pathways, respectively. Shallow groundwater CDIs for the ingestion pathway are provided in Table 6.2.7.10.

6.2.7.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.4 of this report. Table 6.2.7.11 provides toxicological reference information for each COPC identified in soil and groundwater. Presented below are toxicological briefs on each COPC.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the BAP B2 classification is based on insufficient data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question; the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgement of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the dibenz(a,h)anthracene, benzo(a)anthracene, benzo(b)fluoranthene and benzo(k)fluoranthene B2 classification is based on no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.*** USEPA determined RfDs for only two of these compounds: pyrene's RfD_o is 0.03 mg/kg-day is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

PCB Aroclors are a group of chlorinated hydrocarbons (such as ***Aroclor*** **-1248, 1254, and 1260)** that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme concentrations, rashes, chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified PCB Aroclors as group B2 carcinogens, primarily based on animal data. As listed in IRIS (search date 6/29/95), the basis for the classification is hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate yet suggestive evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. USEPA set 7.7 $(mg/kg\text{-}day)^{-1}$ as the SF_o for PCB Aroclors, and the RfD was set to 0.00007 mg/kg-day.

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on an NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingesting these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. As listed in IRIS (search date 9/1/95), the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3μg/L arsenic. The RBC for arsenic in tap water is 0.038 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an AL for soil protective of child residents has been proposed by USEPA Region IV: 400 mg/kg. OSWER has recommended a 1,000 mg/kg cleanup standard for industrial properties. USEPA's Office of Water has established a treatment technique action level of 15 μg/L. As listed in IRIS (search date 10/17/95), classification is based on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD or SF has not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites, and sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

6.2.7.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Tables 6.2.7.12 and 6.2.7.13 present the computed carcinogenic risk and noncarcinogenic HQs associated with the incidental ingestion and dermal contact with surface soil, respectively.

Future Site Residents

The projected ingestion related ILCR from surface soil was 6E-7, and the dermal pathway risk was 3E-7. BEQs and Aroclor-1248 were the primary contributors for both pathways. No reference dose was available for any surface soil COPC, and thus no HQs were computed.

Lead Toxicity

The lead concentration at two of four sampling locations (653SB001 and 653SB003) exceeded the 400 mg/kg residential soil screening value. The mean lead concentration in AOC 653 soil was computed to be 303 mg/kg, which is below 400 mg/kg, the level proven to protective of a residential child, assuming that the potable water source does not exceed the USEPA's treatment technique action level of 15 μg/L. As a result, the USEPA Lead Model would not be expected to predict a concern for possible child receptors based on chronic exposure to lead concentrations reported in AOC 653 soil. In contrast to the 400 mg/kg cleanup goal based on child resident exposure, USEPA Region IV has calculated a soil cleanup/screening level for lead of 1,300 mg/kg based on adult exposures. The most likely receptors, considering the proposed industrial use of the AOC 653 area, are adults rather than children. The maximum surface soil concentration for AOC 653 (561 mg/kg) falls below the USEPA cleanup/screening level based on adult exposure.

Future Site Workers

The projected ingestion related ILCR from surface soil was 7E-8, and the dermal pathway risk was 1E-7. BEQs were the only contributors for both pathways. No reference dose is available for BAP, and thus no HQs were computed. The maximum lead concentration detected in AOC

653 surface soil (561 mg/kg) is less than the RCRA cleanup goal of 1,000 mg/kg recommended by OSWER for industrial properties.

Because site worker risk projections did not exceed the most conservative 1E-6 point of departure assuming that all surface soil was accessible for contact exposure, no formal assessment was performed considering the influences of existing site features. It should be noted, however, that more than 90% of the surface area at AOC 653 is paved, thus precluding exposure to underlying soil if existing features remain intact.

Groundwater

Exposure to shallow groundwater was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion exposure was considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Table 6.2.7.14 presents the computed carcinogenic risk and noncarcinogenic HQs associated with the potable use ingestion of shallow groundwater.

Future Site Residents

The projected ingestion-related ILCR from shallow groundwater was 8E-4. The HIs for adult and child residential receptors were computed to be 3 and 7, respectively. Arsenic was the sole contributor for the pathway in both instances.

Future Site Workers

The projected ingestion-related ILCR from shallow groundwater was 2E-4, and the site worker HQ was 1. Arsenic was the sole contributor in both instances.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 653 or other Zone H areas. In the absence of a completed exposure pathway shallow groundwater contamination poses no threat to human health.

COCs Identified

Arsenic was the sole COC identified at AOC 653. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or an HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is comparatively conservative because a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

Surface Soil

Hypothetical Site Residents

The mean lead concentration (303 mg/kg) was found not to exceed the USEPA ORD 400 mg/kg standard although the residential cleanup standard was exceeded at two sampling locations. As a result, lead was not considered a COC for this site.

Hypothetical Site Workers

No COCs were identified for this scenario based on lead's contribution to risk/hazard.

Groundwater

Hypothetical Site Residents

Arsenic was the only COC identified for this scenario based on its contribution to risk/hazard.

Hypothetical Site Workers

Arsenic was the only COC identified for this scenario based on its contribution to risk/hazard.

6.2.7.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for overestimating exposure is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site surface soil or groundwater. The entire investigative area is covered by an asphalt surface. If existing features remain intact under the future site use, the surface soil exposure pathway would not be completed.

Residential use of the site would not be expected, based on current site uses and the nature of the surrounding buildings. Current base reuse plans call for use of AOC 653 and surrounding areas as a cargo terminal. If this area is used as a residential site, the buildings will be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at AOC 653 for potable or industrial purposes. A basewide system providing drinking and process water to buildings throughout Zone H is to remain in operation under the current base reuse plan. As a result, shallow groundwater use would not be expected under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Because there were fewer than 10 surface soil samples, all of the EPCs used for this site are the maximum concentrations reported for the respective COPCs. The surface soil EPCs were modified (where appropriate) to account for the reasonable FI/FC from the contaminated source. Risk values for shallow groundwater based on maximum concentrations are likely to be overestimates.

Frequency of Detection and Spatial Distribution

Lead was present in all four soil samples, and concentrations reported at 653SB001 and 653SB003 exceeded 400 mg/kg. The average lead concentration was computed to be less than the USEPA residential cleanup standard, and thus the chronic EPC for future child residents would be expected to be less than the maximum concentration. Aroclor-1248, Aroclor-1260, and BAP were each detected in only one of seven soil samples (i.e., all were reported in sample 653B001). This limited areal extent was used to derive the FI/FC factor discussed in the preceding paragraph.

Elevated TPH results (730 to 36500 mg/kg) were reported in soil onsite. No groundwater sample contained detectable TPH concentrations, indicating that the shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of TPH constituents. An AL of 100 mg/kg has been established for NAVBASE soil TPH.

In groundwater, arsenic was the only COC identified. It was detected in one second-quarter sample at a concentration of 0.0345 mg/L. Based on this limited data set, it cannot be definitively determined whether chronic exposure at the EPC applied is a reasonable estimate.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty and/or variability in the output of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration close to its corresponding RBC (i.e., within approximately 10%. Concentrations of beryllium and manganese exceed their corresponding RBCs, but maximum concentrations of these elements do not exceed the corresponding reference concentrations. Therefore, they were eliminated from formal assessment based on comparisons to the reference concentrations.

Groundwater

Arsenic, the sole shallow groundwater COPC, was detected at a maximum concentration of 0.0345 mg/L in one second-quarter sample, and would not be expected to be associated with current and past operations. This maximum concentration is below the ARAR of 0.05 mg/L. It must also be noted that arsenic was not a soil COPC based on comparison to reference concentrations. This suggests that no source is associated with past or current site operations. The nature of past and current operations would not present an identifiable source of arsenic. In the absence of a source, it may be concluded that detected groundwater arsenic is representative of natural conditions. Continued monitoring should serve to confirm or refute this preliminary conclusion, facilitating sound risk management decisions.

Of the CPSSs screened and eliminated from the formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC, minimizing the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs.

Although the future land use at this site is unknown, both the worker and residential exposure scenarios were assessed. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard. An individual site map was not produced for this site.

The CT assumption for residential exposure duration is nine years compared to the 30-year assumption for RME. If all other exposure assumptions remain fixed, application of the CT exposure duration would result in risk projections 66% below the RME presented in Table 6.2.7.14. At CT, the shallow groundwater related risk (incidental ingestion) would be approximately 3E-4, which still exceeds the USEPA and SCDHEC point of departure.

6.2.7.7 Risk Summary

The risk and hazard posed by contaminants at AOC 653 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed. Ingestion was the sole pathway evaluated relative to shallow groundwater. Table 6.2.7.15 summarizes risk for each pathway/receptor group evaluated for AOC 653.

6.2.7.8 Remedial Goal Options

Soil

No surface soil COCs were identified at AOC 653. Therefore, no RGOs were computed.

Groundwater

RGOs for the shallow aquifer were calculated for both future residential and site workers, as provided in Tables 6.2.7.16 and 6.2.7.17, respectively. Arsenic was the sole COC for which RGOs were calculated; the maximum reported concentration is below the ARAR MCL (0.05 mg/L).

Table 6.2.7.1
Methods Run at AOC 653
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
653	B001	S	S	S	Y					S	Y					
653	B002	S	S	S	Y					S	Y					
653	B003	B	B	B	Y	Y	Y	Y	A	B	B					
653	B004	S	S	S	Y					S	Y					
653	B005						Y									
653	B006		S				Y			S						
653	B007		S				Y			S						
653	B008		S				Y			S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.7.2
Methods Run at AOC 653
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
653	W001	S	S	S	Y					S	Y					
653	W002	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.7.3
Methods Run at AOC 653
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
653	W001	S	S							S						
653	W002	S	S							S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II:	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.7.4
AOC 653
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	4/ 4		25.000 - 131.500	66.375	780000.0000			
Acrylonitrile	UG/KG	1/ 1		23.900 - 23.900	23.900	1200.0000			
Aluminum	MG/KG	4/ 4		2590.000 - 4580.000	3782.500	7800.0000		25310.000	
* Aroclor-1248	UG/KG	1/ 7	40.00 - 400.00	88.000 - 88.000	88.000	83.0000	1		
Aroclor-1260	UG/KG	1/ 7	40.00 - 400.00	71.000 - 71.000	71.000	83.0000			
Arsenic	MG/KG	4/ 4		4.700 - 9.300	6.975	0.3700	4	14.810	
Barium	MG/KG	3/ 4	0.48 - 0.48	36.100 - 49.800	44.733	550.0000		40.330	2
* Benzo(a)pyrene Equivalents	UG/KG	7/ 7		55.000 - 110.000	62.857	88.0000	1		
Benzo(a)pyrene	UG/KG	1/ 7	390.00 - 1660.00	110.000 - 110.000	110.000				
Beryllium	MG/KG	4/ 4		0.260 - 0.390	0.337	0.1500	4	1.470	
2-Butanone (MEK)	UG/KG	1/ 4	28.00 - 31.00	23.400 - 23.400	23.400	4700000.0000			
Butylbenzylphthalate	UG/KG	1/ 7	390.00 - 1660.00	110.000 - 110.000	110.000	1600000.0000			
Cadmium	MG/KG	3/ 4	0.85 - 0.85	0.700 - 0.940	0.853	3.9000		1.050	
Calcium	MG/KG	4/ 4		18400.000 - 225000.000	99125.000				
alpha-Chlordane	UG/KG	2/ 7	4.00 - 40.00	2.000 - 2.000	2.000	470.0000			
gamma-Chlordane	UG/KG	3/ 7	4.00 - 40.00	3.000 - 4.000	3.333	470.0000			
Chromium	MG/KG	4/ 4		11.500 - 18.200	14.537	39.0000		85.650	
Cobalt	MG/KG	4/ 4		1.900 - 5.400	3.575	470.0000		5.860	
Copper	MG/KG	4/ 4		7.700 - 25.350	19.212	290.0000		27.600	
4,4'-DDD	UG/KG	6/ 7	70.00 - 70.00	8.000 - 180.000	60.583	2700.0000			
4,4'-DDE	UG/KG	7/ 7		5.800 - 310.000	79.828	1900.0000			
Dioxin (TCDD TEQ)	PG/G	5/ 5		3.071 - 43.571	15.340	1000.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	4/ 7	410.00 - 3000.00	110.000 - 6695.000	1873.750	46000.0000			
Fluorene	UG/KG	1/ 7	390.00 - 460.00	441.000 - 441.000	441.000	310000.0000			
Iron	MG/KG	4/ 4		3520.000 - 9050.000	6840.000			30910.000	
* Lead	MG/KG	4/ 4		38.200 - 561.000	302.600	400.0000	2	118.000	2
Magnesium	MG/KG	4/ 4		430.000 - 2470.000	1402.500			9592.000	
Manganese	MG/KG	4/ 4		27.800 - 233.000	106.600	39.0000	3	636.400	
Mercury	MG/KG	4/ 4		0.030 - 0.220	0.087	2.3000		0.490	
Methyl parathion	UG/KG	1/ 1		33.200 - 33.200	33.200	2000.0000			
4-Methyl-2-Pentanone (MIBK)	UG/KG	1/ 4	28.00 - 31.00	1.600 - 1.600	1.600	390000.0000			
2-Methylnaphthalene	UG/KG	1/ 7	390.00 - 460.00	1520.000 - 1520.000	1520.000	310000.0000			
4-Methylphenol	UG/KG	1/ 7	390.00 - 1660.00	260.000 - 260.000	260.000	39000.0000			
Naphthalene	UG/KG	1/ 7	390.00 - 460.00	739.000 - 739.000	739.000	310000.0000			

Table 6.2.7.4
AOC 653
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Nickel	MG/KG	4/ 4		5.500 - 12.700	8.825	160.0000		33.380	
Phenanthrene	UG/KG	1/ 7	390.00 - 460.00	711.000 - 711.000	711.000	310000.0000k			
Pyrene	UG/KG	2/ 7	390.00 - 460.00	110.000 - 801.000	455.500	230000.0000			
Sodium	MG/KG	4/ 4		117.000 - 460.000	232.000				
* Petroleum Hydrocarbons, TPH	MG/KG	4/ 4		730.000 - 36500.000	11257.500	10.0000	4		
Toluene	UG/KG	4/ 4		6.000 - 20.000	10.125	1600000.0000			
Vanadium	MG/KG	4/ 4		12.000 - 18.000	13.850	55.0000		77.380	
Xylene (total)	UG/KG	1/ 4	6.00 - 6.00	2.200 - 2.200	2.200	16000000.0000			
Zinc	MG/KG	4/ 4		55.300 - 165.500	97.600	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- i Naphthalene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.7.5
AOC 653
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Calcium	UG/L	2/ 2			44300.000 -	108000.000	76150.000				
4,4'-DDT	UG/L	1/ 2	0.10 -	0.10	0.060 -	0.060	0.060	0.2000			
Iron	UG/L	2/ 2			6230.000 -	9280.000	7755.000				
Magnesium	UG/L	2/ 2			59900.000 -	86200.000	73050.000				
Manganese	UG/L	2/ 2			90.600 -	672.000	381.300	18.0000	2	3391.000	
Potassium	UG/L	2/ 2			52300.000 -	58200.000	55250.000				
Selenium	UG/L	2/ 2			0.900 -	1.200	1.050	18.0000		3.150	
Sodium	UG/L	2/ 2			598000.000 -	707000.000	652500.000				
Thallium	UG/L	1/ 2	1.00 -	1.00	1.200 -	1.200	1.200	0.2900	1	7.660	
Vanadium	UG/L	1/ 2	3.10 -	3.10	4.600 -	4.600	4.600	26.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.7.6
AOC 653
Shallow Groundwater Sampling Round 02

	Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
	Aluminum	UG/L	2/ 2		189.000 - 248.000	218.500	3700.0000			
*	Arsenic	UG/L	1/ 2	17.00 - 17.00	36.550 - 36.550	36.550	0.0380	1	27.990	1
	Calcium	UG/L	2/ 2		56700.000 - 94200.000	75450.000				
	Iron	UG/L	2/ 2		9510.000 - 10550.000	10030.000				
	Magnesium	UG/L	2/ 2		60600.000 - 66850.000	63725.000				
	Manganese	UG/L	2/ 2		128.000 - 680.000	404.000	18.0000	2	3391.000	
	Potassium	UG/L	2/ 2		37850.000 - 44300.000	41075.000				
	Sodium	UG/L	2/ 2		476500.000 - 539000.000	507750.000				

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.7.7
Exposure Pathways Summary — AOC 653
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 653.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 653.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	No CPSSs were greater than RBC and Reference concentrations.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	No significant VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs.

Table 6.2.7.7
Exposure Pathways Summary — AOC 653
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.7.8
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 653
Naval Base Charleston
Charleston, SC

Chemical	TEF	Fraction Ingested from Contaminated Source	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1248	NA	0.2	0.088	2.41E-08	2.25E-07	2.76E-08	8.61E-09	3.08E-09
Benzo(a)pyrene Equivalents	1	0.2	0.11	3.01E-08	2.81E-07	3.44E-08	1.08E-08	3.84E-09
Lead	NA	1	561	7.68E-04	7.17E-03	8.78E-04	2.74E-04	9.80E-05
Aroclor-1260	NA	0.2	0.071	1.95E-08	1.82E-07	2.22E-08	6.95E-09	2.48E-09

NOTES:

TEF toxic equivalency factor relative to Benzo(a)pyrene
lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 6.2.7.9
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 653
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1248	NA	0.088	0.2	0.01	9.88E-09	3.26E-08	6.19E-09	7.06E-09	2.52E-09
Benzo(a)pyrene Equivalents	1	0.11	0.2	0.01	1.24E-08	4.08E-08	7.73E-09	8.83E-09	3.15E-09
Lead	NA	561	1	0.001	3.15E-05	1.04E-04	1.97E-05	2.25E-05	8.04E-06
Aroclor-1260	NA	0.071	0.2	0.01	7.98E-09	2.63E-08	4.99E-09	5.70E-09	2.03E-09

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 6.2.7.10
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 653
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Arsenic	0.0345	9.45E-04	2.21E-03	5.20E-04	3.38E-04	1.21E-04

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

able 6.2.7.11 - AOC 653
oxicological Database Information
r Chemicals of Potential Concern
AVBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

hemical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation
rsenic	0.0003	a	M	hyperpigmentation	3	ND			ND
ead	ND				ND	ND			ND
CB Aroclor-1248	ND				ND	ND			ND
CB Aroclor-1260	ND				ND	ND			ND
enzo(a)pyrene Equivalents	ND				ND	ND			ND

NOTES:

a Integrated Risk Information System (IRIS)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

ble 6.2.7.11 - AOC 653
xicological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Carcinogenic Toxicity Data

emical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
senic	1.5	a	15.1	a	A	various
ad	ND		ND		B2	various
B Aroclor-1248	7.7		ND		B2	hepatocellular carcinoma
B Aroclor-1260	7.7		ND		B2	hepatocellular carcinoma
nzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen

Table 6.2.7.12
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 653
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1248	NA	7.7	ND	ND	2.1E-07	ND	2.4E-08
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.5E-07	ND	2.8E-08
Lead	NA	NA	ND	ND	ND	ND	ND
Aroclor-1260	NA	7.7	ND	ND	1.7E-07	ND	1.9E-08
SUM Hazard Index/ILCR			ND	ND	6E-07	ND	7E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.7.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 653
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1248	0.5	NA	15.4	ND	ND	9.5E-08	ND	3.9E-08
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.1E-07	ND	4.6E-08
Lead	0.2	NA	NA	ND	ND	ND	ND	ND
Aroclor-1260	0.5	NA	15.4	ND	ND	7.7E-08	ND	3.1E-08
SUM Hazard Index/ILCR				ND	ND	3E-07	ND	1E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.7.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 653
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Arsenic	0.0003	1.5	3.2	7.4	7.8E-04	1.1	1.8E-04
SUM Hazard Index/ILCR			3.2	7	8E-04	1.1	2E-04

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.7.15
Summary of Risk and Hazard for AOC 653
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	6E-07	ND	7E-08
	Dermal Contact	ND	ND	3E-07	ND	1E-07
Shallow Groundwater	Ingestion	3	7	8E-04	1	2E-04
Sum of All Pathways		3	7	8E-04	1	2E-04

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 6.2.7.16
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 653 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options **0.1** mg/l	**1.0** mg/l	**3** mg/l	Risk-Based Remedial Goal Options **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	Background Concentration mg/l
Arsenic	1.5	0.0003	0.0345	0.0005	0.005	0.01	0.00004	0.0004	0.004	0.05	0.028

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.7.17
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 653 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
Arsenic	1.5	0.0003	0.0345	0.003	0.03	0.09	0.00019	0.0019	0.02	0.05	0.028

NOTES:
EPC exposure point concentration
NA not applicable
ND not determined

6.2.8 Baseline Risk Assessment for AOC 655

6.2.8.1 Site Background and Investigative Approach

AOC 655 was investigated to assess soil and groundwater that were potentially affected by a 1985 fuel oil spill from Building 656, the Base Exchange. Soil and groundwater sampling focused on an area immediately behind the building. A soil-gas investigation conducted near Building 656 identified a relatively high response for acetone near the reported spill. Air sampling was conducted inside the building and through cracks in the building floor concurrent with the soil-gas survey. The FFI report, produced in conjunction with this report, summarizes the sampling results and provides a risk assessment for the inhalation exposure pathway. Because Building 656 is within the boundaries of AOC 655, FFI findings specific to Building 656 are summarized in the following subsections.

In all, 14 samples were collected from surface interval (0 to 1 foot deep). Table 6.2.8.1 shows each surface soil designation and the list of analytical methods used for each. Samples were collected from three shallow monitoring wells during two quarterly monitoring events. Tables 6.2.8.2 and 6.2.8.3 list the methods used to analyze the corresponding groundwater samples.

6.2.8.2 COPC Identification

Soil

Based on the screening comparisons described earlier, this HHRA focused on the following soil COPCs: Aroclor-1254, Aroclor-1260, BEQs, and dieldrin. Results of the Wilcoxon rank sum test indicate that no inorganic chemical population significantly differs from that of background sampling locations. TPH was identified in four of seven surface soil samples analyzed at concentrations ranging between 75 and 150 mg/kg. The maximum reported concentration exceeds the NAVBASE soil AL of 100 mg/kg. Indeterminate lubricating oils were also detected in all five samples analyzed at concentrations ranging from 12.5 to 35 mg/kg. The sum of TPH and oil concentrations at each location may indicate whether the NAVBASE TPH AL has been exceeded.

Groundwater

As shown in Table 6.2.8.5, COPCs identified in first-quarter shallow groundwater samples for AOC 655 are chlordane and arsenic. Second-quarter samples also contained chlordane and arsenic although chlordane was not detected in excess of its tap water RBC (Table 6.2.8.6). Wilcoxon rank sum test results indicate that arsenic concentrations were higher than background, but at a significance level of 0.051 rather than the specified level of 0.05. The test used only three site samples rather than the recommended four to compare to background samples, thereby making it more difficult to achieve the required significance level.

Air

The FFI report summarizes the sampling results and provides a risk assessment for the inhalation exposure pathway. As shown in Table 25 of the report, three COPCs were identified for the air pathway at Building 656: benzene, chloromethane, and methylene chloride.

6.2.8.3 Exposure Assessment

Exposure Setting

AOC 655 is the area behind and around Building 656, the Base Exchange. Approximately 300 gallons of No. 2 fuel oil spilled from a ruptured fuel line within Building 656 in 1985. Approximately 150 of the 300 gallons of fuel oil migrated through a seam in the floor of the building to the soil. The fuel oil is supplied by a nearby 5,800-gallon UST. Building 656 is used as a retail facility for the installation. Current base reuse plans call for developing this area as a maritime industrial park.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed in this risk assessment. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions and the use of shallow groundwater as a potable water source. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact and the fact that groundwater is not currently used onsite. Therefore, future worker assessment is considered protective of current site users.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of surface soil. The exposure pathways for future residential land use are the same as those for the future site worker. In addition, the hypothetical future site worker scenario assumed continuous exposure to surface soil and groundwater conditions. Uniform exposure was assumed for all sample locations. Table 6.2.8.7 justifies exposure pathways assessed in this HHRA. The inhalation pathway was investigated as part of the FFI, which includes a risk assessment for the inhalation exposure pathway for current area building workers and future users.

Exposure Point Concentrations

Fewer than 10 shallow groundwater samples were collected during the RFI. As a result, the maximum concentration of each COPC was used as the EPC for the medium. At least 10 surface soil samples were collected at AOC 655. Fourteen surface soil samples were analyzed for pesticides and PCBs. Table 6.2.8.8 presents the statistical analyses performed to compute 95% UCL mean concentrations for each soil COPC.

Quantification of Exposure

Soil

CDIs for ingestion of and dermal contact with soil are shown in Tables 6.2.8.9 and 6.2.8.10, respectively.

Groundwater

Shallow groundwater CDIs for the ingestion pathway are presented in Table 6.2.8.11.

6.2.8.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.4 of this report. Table 6.2.8.12 provides toxicological reference information for each COPC identified in soil and groundwater. Presented below are toxicological profiles on each surface soil and shallow groundwater COPC. Air pathway COPC toxicological briefs and reference information are provided in Section 5 of the FFI report.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soots, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the BAP B2 classification is based on insufficient human data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question; the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is based on no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene***. USEPA determined RfDs for only two of these compounds: pyrene's RfD_o is 0.03 mg/kg-day, and this RfD is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

PCB Aroclors are a of chlorinated hydrocarbons (such as ***Aroclor-1248, 1254, and 1260***) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme levels, rashes, and chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified PCB Aroclors as group B2 carcinogens, primarily based on animal data. As listed in IRIS (search date 6/29/95), the classification is based on hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate yet suggestive evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. USEPA set 7.7 $(mg/kg\text{-}day)^{-1}$ as the SF_o for PCB Aroclors, and the RfD was set to 0.00007 mg/kg-day.

Chlordane is a polycyclic chlorinated pesticide. Acute exposure to high doses of chlordane causes tremors and convulsions. Chronic exposure can cause emotional and neuromuscular disturbances. Exposed individuals revert to normal approximately one week after the source is removed (Dreisbach et al., 1987). USEPA has established an oral RfD of 6E-5 mg/kg-day and an oral SF of 1.3 (mg/kg-day)$^{-1}$.

Dieldrin is a polycyclic chlorinated pesticide. Short-term exposure to high doses causes tremors and convulsions. Chronic exposure can cause emotional and neuromuscular disturbances. Exposed individuals revert to normal approximately one week after the dieldrin source is removed (Dreisbach et al., 1987). As listed in IRIS (search date 6/28/95), the B2 classification is based on a study using seven strains of mice in which dieldrin was administered orally. Dieldrin is structurally related to compounds (aldrin, chlordane, heptachlor, heptachlor epoxide, and chlorendic acid) which produce tumors in rodents. Dieldrin is classified as a B2 carcinogen by USEPA; the SF_o, SF_i, and RfD_o were set to 16 (mg/kg-day)$^{-1}$, 16.1 (mg/kg-day)$^{-1}$, and 0.00005 mg/kg-day, respectively. As listed in IRIS (search date 6/28/95), the critical effect of this chemical is liver lesions. The uncertainty factor was 100 and the modifying factor was 1.

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al, 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on an NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingesting these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 (mg/kg-day)$^{-1}$ SF for arsenic. As listed in IRIS (search date 9/1/95), the classification is based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.038 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

6.2.8.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 6.2.8.13 and 6.2.8.14 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soil, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 655 surface soil is 2E-5. The dermal pathway ILCR is 9E-6. BEQs were the primary contributors with Aroclor-1254 and 1260, and dieldrin contributing the remainder.

For the soil ingestion pathway, the computed HI for the adult resident is 0.007; for the child resident, the HI is 0.07. The primary contributor is PCB Aroclor-1254.

The dermal contact pathway HI are 0.006 and 0.02 for the adult resident and the child resident, respectively.

Hypothetical Site Workers

Site worker ILCRs are 2E-6 and 4E-6 for the ingestion and dermal contact pathways, respectively. BEQs were the only COPCs which contribute more than 1E-6 to the sum ILCR for both scenarios. HI for the ingestion and dermal hypothetical pathways were both projected to be less than 0.1 for the hypothetical site worker scenario.

Existing site features would not have a significant influence on potential exposure to affected surface soil. Most samples were collected in grassy areas near the west side building entrance, north and east building foundations, and the loading dock on the southern end of the building.

Groundwater

Exposure to shallow groundwater was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion exposure was considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Table 6.2.8.15 presents the computed carcinogenic risk and noncarcinogenic HQs associated with the potable use ingestion of shallow groundwater.

Future Site Residents

The projected ingestion-related ILCR from shallow groundwater was 1E-3. The HIs for adult and child residential receptors were computed to be 4 and 9, respectively. Arsenic was the primary contributor for the pathway in both instances.

Future Site Workers

The projected ingestion-related ILCR from shallow groundwater was 2E-4, and the site worker HI was 1. Arsenic was the primary contributor for the pathway in both instances.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 655 or other areas of Zone H. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

Air Pathway (Refer to FFI Report)

Risk was calculated for the inhalation pathway for various hypothetical scenarios. Estimates of ILCR and HIs are shown in Section 5, Table 43, of the FFI. Although the function of Building 656 is proposed to remain unchanged in the base reuse plans, the ILCR was calculated assuming the future use of Building 656 would be a day care center (possible proposed use). As shown in the FFI (Table 43), the ILCR for the hypothetical child scenario was estimated to be 8E-7, and the ILCR for the hypothetical site resident was estimated to be 6E-6, which were based on exposure assumptions differ from those used for this HHRA. The primary contributors to the ILCRs were benzene and methylene chloride. However, cumulative ILCR of 1E-4 was the risk threshold used to identify COCs in the FFI. Therefore, as stated in Section 5.5.4.4 of the FFI, no COCs were identified for the inhalation exposure pathway at Building 656.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site, as shown in Table 6.2.8.16. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a HI threshold of 1.0 (unity). In Zone H HHRAs, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a cumulative HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is relatively conservative, because USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

Surface Soil

*Hypothetical Site Residents (future land use)*Aroclor-1254 and -1260, BEQs, and dieldrin were identified as COCs for surface soil based on their contribution to ILCR. No hazard-based COCs were identified for the site resident scenario.

assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site groundwater. They are infrequently exposed to surface soil when walking across the site, using commercial facilities or mowing grass. Site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. Mowing grass 52 days per year would result in one-fifth the projected risk/hazard for site workers. The thick vegetative cover in most areas sampled prevent most direct contact and thus exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone H as a maritime industrial park. If this area were to be used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at AOC 655 for potable or industrial purposes. A basewide system providing drinking and process water to buildings throughout Zone H is to remain in operation under the current base reuse plan. As a result, shallow groundwater use would not be expected used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The UCLs of the reported surface soil concentrations were used as the EPCs for this site. Because fewer than 10 groundwater samples were used to assess this AOC, the maximum concentrations reported in groundwater were used to calculate risk/hazard for chlordane and arsenic.

Frequency of Detection and Spatial Distribution

No factors were derived to account for the potential FI/FC from the contaminated source for any COPC. Both BEQs and dieldrin were detected infrequently in surface soil. Dieldrin was found, however, at multiple locations preventing derivation of a valid FI/FC factor. BEQs were detected above the residential RGO in only one sample (SGCSB901). This sample location was not originally intended for inclusion with the AOC 655 dataset. Based on the suspected source of BEQs (loading dock-related exhaust and oil leakage), impacts would not be suspected to be widespread; however, limited sampling conducted in the immediate vicinity did not support derivation of an FI/FC. A preliminary evaluation based on available data indicates an FI/FC of 0.1 would provide a conservative estimate of chronic exposure.

Slightly elevated TPH (75 to 120 mg/kg) and indeterminate lubricating oil (12.5 to 35 mg/kg) results were reported in soil onsite. No groundwater sample contained detectable concentrations of TPH, indicating that the shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of TPH constituents. An AL of 100 mg/kg has been established for NAVBASE soil TPH.

In groundwater, chlordane and arsenic were the only COCs identified. Both were in at least one shallow monitoring well during first- and second-quarter sampling events. Based on this dataset, confidence is moderate to high that the EPC applied is a reasonable estimate of maximum. No significant soil source of arsenic was identified.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

To quantify the potential variability of project risk/hazard for soil and groundwater pathways, CT was analyzed. Exposure assumptions were modified to reflect 50th percentile rather the 95th, and EPCs were maintained. In accordance with *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure-Draft* (USEPA, 1993), the exposure duration of site residents was reduced from 30 years to nine years (two years for childhood exposure and seven years for adult exposure). Residential exposure frequency was reduced from 350 to 234 days/year, and occupational exposure frequency was amended from 250 to 219 days/year. The drinking water ingestion rate for an adult was reduced from 2 to 1.4 liters/day, and exposure to site groundwater was reduced by 25% to account for other water sources. Soil ingestion rates for resident adults and children were reduced by 50% to 50 and 100 mg/day, respectively. Dermal surface area estimates remained static in the CT analyses.

Soil

Of the CPSSs screened and eliminated from formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration close to its corresponding RBC (i.e., within approximately 10% of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Concentrations of aluminum, arsenic, beryllium, and manganese exceed their corresponding RBCs, but maximum concentrations of these elements do not exceed the corresponding reference concentrations. They were eliminated from formal assessment based on comparisons to the reference concentrations because they do not contribute to excess risk/hazard onsite.

Although the future land use at this site is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely overestimate risk and/or hazard.

Tables 6.2.8.17 and 6.2.8.18 provide CT-based CDI estimates for the incidental ingestion and dermal contact soil pathways, respectively. Tables 6.2.8.19 and 6.2.8.20 present CT-based risk/hazard estimates for the incidental ingestion and dermal contact soil pathways, respectively. The combined soil pathway risk for future resident was calculated to be 4E-6 compared to the RME-based estimate of 3E-5. BEQs are the only COCs for soil pathways under the future resident exposure scenario. For current/future site workers, the combined soil pathway risk was estimated at 1E-6 compared to 6E-6 under RME conditions. No individual COPC was found to pose a risk in excess of 1E-6.

Groundwater

Of the CPSSs screened and eliminated from formal assessment, barium was reported at concentrations approaching its corresponding RBC. The screening value for barium is based on an HQ goal of 0.1, and its influence would not be expected to increase the calculated sum HI for the groundwater pathway. This analysis minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. The maximum concentration reported for manganese exceeded the corresponding RBC, but this essential element did not exceed the corresponding reference concentration. Therefore, manganese was eliminated from formal assessment based on comparison to the corresponding reference concentration. As reported in Section 6.2.8.2, results of the Wilcoxon rank sum test indicate that arsenic concentrations in shallow groundwater are not significantly higher than background at AOC 655, but only because the significance level of the test was 0.051 rather than the specified 0.05. The Wilcoxon test was applied although there were only three site samples to compare to background rather than the recommended four. Therefore, arsenic was retained as a COPC and formally assessed.

Chlordane and arsenic were the only COPCs identified for shallow groundwater at AOC 655. Neither groundwater COPC would be associated with fuel oil. Therefore, the presence of these chemicals does not appear to be linked to the 1985 spill. Arsenic, the primary shallow groundwater COC, was detected at a maximum concentration of 0.0423 mg/L in first-quarter samples. This maximum concentration is below the ARAR of 0.05 mg/L. Additionally, the hit used to develop the shallow groundwater EPC for arsenic was the sole detection in excess of reference concentrations. It must also be noted that arsenic was not a soil COPC based on comparison to reference concentrations. This suggests no source associated with past or current site operations. The nature of past and current operations would not present an identifiable source of arsenic. In the absence of a source, it may be concluded that detected groundwater arsenic is representative of natural conditions. Continued monitoring should serve to confirm this preliminary conclusion, facilitating risk management decisions.

Groundwater is not currently a potable water source at AOC 655, nor is it used on the naval base or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is also probable that, if residences were constructed onsite and an unfiltered well was installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source. The quality of Zone H groundwater was discussed in Section 3 of this report, and the conclusion was reached that the groundwater is not suitable for potable use based on the water quality data in Section 3.2.10, Table 3.4. The nonpotability determination was made independent of site-related influences.

Table 6.2.8.21 provides CT-based CDI estimates for the shallow groundwater ingestion pathway. Table 6.2.8.22 presents CT-based risk/hazard estimates for the ingestion pathway. The shallow groundwater pathway risk for future resident was calculated to be 1E-4 compared to the RME-based estimate of 1E-3. Arsenic is the sole significant contributor to this estimate. For current/future site workers, the shallow groundwater pathway risk was estimated at 4E-5 compared to 2E-4 under RME conditions. Arsenic was the only COC identified based on ILCR.

Air (Refer to FFI Report)

As stated in Section 5.5.4.4 of the FFI, no COCs were identified for this scenario based on the sum ILCR and HI for Building 656. As previously discussed, the ILCR threshold used in the FFI to identify COCs for the air exposure pathway was 1E-4. In addition, exposure assumptions used in the FFI differ from those used to quantify exposure in this HHRA. Uncertainty for the air pathway is discussed in Section 5.6 of the FFI. Based on application of CT exposure assumptions for exposure duration and frequency, the projected risk associated with each carcinogenic air pathway contaminant identified in Building 656 was reduced by a factor of 5.

6.2.8.7 Risk Summary

The risk and hazard posed by contaminants at AOC 655 were assessed for the hypothetical RME site worker and the hypothetical future site resident scenarios. In surface soil, the incidental ingestion and dermal contact pathways were assessed. The Final FFI Report summarizes the sampling results and assesses the risk for the inhalation exposure pathway. Table 6.2.8.23 presents the risk/hazard summary for AOC 655.

6.2.8.8 Remedial Goal Options

Soil

RGOs for the hypothetical site residential scenario were calculated for Aroclor-1254 and 1260, BEQs and dieldrin as shown in Table 6.2.8.24. Worker-based RGOs for BAP, the only industrial scenario soil COC, are provided in Table 6.2.8.25. Inclusion in an RGO table does not necessarily indicate that remedial action is warranted. RGOs are options to be considered when making risk management decisions which, in accordance with RAGS, are not to be included in HHRAs.

Groundwater

RGOs for the shallow aquifer were calculated for both future residential and site workers, as provided in Tables 6.2.8.26 and 6.2.8.27, respectively. Arsenic and chlordane were the only

COCs for which RGOs were calculated under the residential scenario. Only arsenic was identified as a COC for future site workers. The maximum reported arsenic concentration at AOC 655 is below the ARAR MCL (0.05 mg/L).

Table 6.2.8.1
Methods Run at AOC 655
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
655	B001	S	S	S	Y					S	Y					
655	B002	S	S	S	Y					S	Y					
655	B003	S	S	S	Y					S	Y					
655	B004	S	S	S	Y					S	Y					
655	B005	S	S	S	Y					S	Y					
655	B006	S	S	S	Y					S	Y					
655	B007	S	S	S	Y					S	Y					
655	B008	S	S	S	Y					S						
655	B009									S	Y					
655	B010									S	Y					
655	B011									S	Y					
655	B012									S	Y					
655	B013	A	A	A	Y	Y	Y	Y	A	B	B					
655	B04A													Y	Y	Y
655	B05A													Y	Y	Y
655	SGC9	S	S	S	Y					S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.8.2
Methods Run at AOC 655
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
655	W001	S	S	S	Y					S	Y					
655	W002	S	S	S	Y					S	Y					
655	W003	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.8.3
Methods Run at AOC 655
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
655	W001	S	S							S						
655	W002	S	S							S						
655	W003	S	S							S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.8.4
AOC 655
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/KG	1/ 10	333.00 - 560.00	140.000 - 140.000	140.000	470000.0000			
Acenaphthylene	UG/KG	1/ 10	333.00 - 560.00	440.000 - 440.000	440.000	470000.0000c			
Acetone	UG/KG	9/ 10	25.30 - 25.30	17.000 - 4400.000	579.777	780000.0000			
Aluminum	MG/KG	9/ 9		2500.000 - 15300.000	6110.000	7800.0000	3	25310.000	
Anthracene	UG/KG	1/ 10	333.00 - 560.00	1800.000 - 1800.000	1800.000	2300000.0000			
* Aroclor-1254	UG/KG	3/ 14	30.00 - 200.00	81.000 - 110.000	95.000	83.0000	2		
* Aroclor-1260	UG/KG	9/ 14	40.00 - 200.00	25.800 - 610.000	164.866	83.0000	5		
Arsenic	MG/KG	9/ 10	1.50 - 1.50	1.400 - 12.700	4.766	0.3700	9	14.810	
Barium	MG/KG	8/ 10	0.09 - 4.70	3.400 - 23.200	12.450	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	1/ 10	333.00 - 560.00	960.000 - 960.000	960.000	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	10/ 10		361.915 - 3590.700	770.996	88.0000	10		
Benzo(a)anthracene	UG/KG	2/ 10	333.00 - 560.00	91.000 - 3300.000	1695.500				
Benzo(b)fluoranthene	UG/KG	2/ 10	333.00 - 560.00	120.000 - 2100.000	1110.000				
Chrysene	UG/KG	2/ 10	333.00 - 560.00	100.000 - 2700.000	1400.000				
Dibenzo(a,h)anthracene	UG/KG	1/ 10	333.00 - 560.00	520.000 - 520.000	520.000				
Indeno(1,2,3-cd)pyrene	UG/KG	1/ 10	333.00 - 560.00	1100.000 - 1100.000	1100.000				
Benzo(k)fluoranthene	UG/KG	1/ 10	333.00 - 560.00	1800.000 - 1800.000	1800.000				
Benzo(a)pyrene	UG/KG	1/ 10	333.00 - 560.00	2400.000 - 2400.000	2400.000				
Beryllium	MG/KG	9/ 10	0.10 - 0.10	0.090 - 0.910	0.300	0.1500	7	1.470	
2-Butanone (MEK)	UG/KG	1/ 10	10.00 - 59.00	19.000 - 19.000	19.000	4700000.0000			
Butylbenzylphthalate	UG/KG	1/ 10	333.00 - 560.00	98.000 - 98.000	98.000	1600000.0000			
Cadmium	MG/KG	6/ 10	0.10 - 0.18	0.240 - 0.560	0.356	3.9000		1.050	
Calcium	MG/KG	9/ 9		1560.000 - 152000.000	42012.222				
alpha-Chlordane	UG/KG	9/ 14	4.00 - 5.00	4.000 - 97.000	35.972	470.0000			
gamma-Chlordane	UG/KG	9/ 14	4.00 - 5.00	4.000 - 130.000	45.422	470.0000			
Chromium	MG/KG	10/ 10		5.300 - 35.800	15.660	39.0000		85.650	
Cobalt	MG/KG	9/ 10	1.00 - 1.00	0.600 - 5.200	1.902	470.0000		5.860	
Copper	MG/KG	9/ 10	1.10 - 1.10	1.400 - 41.600	10.911	290.0000		27.600	1
Cyanide	MG/KG	1/ 10	0.80 - 1.00	1.500 - 1.500	1.500	160.0000			
4,4'-DDE	UG/KG	6/ 14	3.00 - 20.00	2.600 - 13.000	4.766	1900.0000			
4,4'-DDT	UG/KG	4/ 14	3.30 - 40.00	4.000 - 23.000	11.250	1900.0000			
Dibenzofuran	UG/KG	1/ 10	333.00 - 560.00	210.000 - 210.000	210.000	31000.0000			
* Dieldrin	UG/KG	4/ 14	3.00 - 20.00	2.400 - 360.000	95.850	40.0000	1		
Dioxin (TCDD TEQ)	PG/G	1/ 1		0.818 - 0.818	0.818	1000.0000			

Table 6.2.8.4
AOC 655
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Endosulfan II	UG/KG	1/ 14	7.00 - 40.00	4.000 - 4.000	4.000	47000.0000			
Endrin aldehyde	UG/KG	2/ 14	3.30 - 40.00	8.000 - 16.000	12.000	2300.0000h			
bis(2-Ethylhexyl)phthalate	UG/KG	2/ 10	333.00 - 560.00	150.000 - 1800.000	975.000	46000.0000			
Fluoranthene	UG/KG	2/ 10	333.00 - 560.00	170.000 - 4200.000	2185.000	310000.0000			
Fluorene	UG/KG	1/ 10	333.00 - 560.00	660.000 - 660.000	660.000	310000.0000			
Heptachlor	UG/KG	2/ 14	3.00 - 20.00	1.300 - 11.000	6.150	140.0000			
Heptachlor epoxide	UG/KG	5/ 14	3.00 - 20.00	2.000 - 24.000	10.480	70.0000			
* Indeterminate Lubricating Oil	UG/KG	5/ 5		12500.000 - 35000.000	27300.000	10.0000	5		
Iron	MG/KG	9/ 9		2060.000 - 21200.000	6428.888			30910.000	
Lead	MG/KG	5/ 10	4.70 - 14.20	3.200 - 215.000	82.660	400.0000j		118.000	2
Magnesium	MG/KG	9/ 9		276.000 - 5710.000	1548.333			9592.000	
Manganese	MG/KG	9/ 9		13.700 - 382.000	91.988	39.0000	6	636.400	
Mercury	MG/KG	8/ 10	0.03 - 0.03	0.020 - 0.110	0.053	2.3000		0.490	
Methylene chloride	UG/KG	7/ 10	8.90 - 31.00	10.000 - 34.000	19.142	85000.0000			
Nickel	MG/KG	9/ 10	2.40 - 2.40	1.200 - 12.700	5.200	160.0000		33.380	
Phenanthrene	UG/KG	2/ 10	333.00 - 560.00	98.000 - 4200.000	2149.000	310000.0000k			
Potassium	MG/KG	8/ 9	707.00 - 707.00	117.000 - 1670.000	418.625				
Pyrene	UG/KG	2/ 10	333.00 - 560.00	160.000 - 5300.000	2730.000	230000.0000			
Sodium	MG/KG	9/ 9		50.700 - 1270.000	283.555				
* Petroleum Hydrocarbons, TPH	MG/KG	4/ 7	71.00 - 76.00	75.000 - 120.000	95.500	10.0000	4		
Toluene	UG/KG	6/ 10	5.00 - 12.00	2.900 - 8.000	5.700	1600000.0000			
Vanadium	MG/KG	9/ 10	4.70 - 4.70	4.800 - 43.200	15.544	55.0000		77.380	
Zinc	MG/KG	9/ 10	11.20 - 11.20	13.600 - 115.000	51.777	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- e Acenaphthene used as surrogate
- f Fluoranthene used as surrogate
- h Endrin used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.8.5
AOC 655
Shallow Groundwater, Sampling Round 01

	Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
	Aluminum	UG/L	2/ 3	79.50 -	79.50	1040.000 -	1750.000	1395.000	3700.0000			
*	Arsenic	UG/L	2/ 3	9.40 -	9.40	22.900 -	42.300	32.600	0.0380	2	27.990	1
	Barium	UG/L	3/ 3			54.700 -	255.000	125.866	260.0000		323.000	
	Calcium	UG/L	3/ 3			153000.000 -	196000.000	176000.000				
	alpha-Chlordane	UG/L	1/ 3	0.05 -	0.06	0.040 -	0.040	0.040	0.0520			
*	gamma-Chlordane	UG/L	1/ 3	0.05 -	0.06	0.060 -	0.060	0.060	0.0520	1		
	Iron	UG/L	3/ 3			17600.000 -	45400.000	28533.333				
	Magnesium	UG/L	3/ 3			175000.000 -	541000.000	323666.666				
	Manganese	UG/L	3/ 3			298.000 -	578.000	437.666	18.0000	3	3391.000	
	Potassium	UG/L	3/ 3			52200.000 -	161000.000	96500.000				
	Sodium	UG/L	3/ 3			1780000.000 -	3940000.000	2620000.000				
	Vanadium	UG/L	1/ 3	6.50 -	7.50	10.100 -	10.100	10.100	26.0000			

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.8.6
AOC 655
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	UG/L	3/ 3			26.600 -	2210.000	862.866	3700.0000			
Arsenic	UG/L	2/ 3	6.80 -	6.80	10.600 -	27.900	19.250	0.0380	2	27.990	
Barium	UG/L	3/ 3			46.500 -	211.000	111.500	260.0000		323.000	
Calcium	UG/L	3/ 3			159000.000 -	217000.000	180666.666				
alpha-Chlordane	UG/L	1/ 3	0.06 -	0.06	0.030 -	0.030	0.030	0.0520			
gamma-Chlordane	UG/L	1/ 3	0.06 -	0.06	0.040 -	0.040	0.040	0.0520			
Chromium	UG/L	2/ 3	2.00 -	2.00	3.500 -	4.000	3.750	18.0000			
Iron	UG/L	3/ 3			16750.000 -	39300.000	30416.666				
Magnesium	UG/L	3/ 3			122000.000 -	649000.000	362166.666				
Manganese	UG/L	3/ 3			346.000 -	689.000	483.666	18.0000	3	3391.000	
Potassium	UG/L	3/ 3			16900.000 -	90350.000	48750.000				
Sodium	UG/L	3/ 3			1240000.000 -	4570000.000	2890000.000				
Vanadium	UG/L	3/ 3			4.000 -	10.100	7.966	26.0000			
Zinc	UG/L	1/ 3	5.80 -	5.80	7.700 -	7.700	7.700	1100.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.8.7
Exposure Pathways Summary — AOC 655
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	Yes	The Final Focused Field Investigation summarizes the sampling results and provides a risk assessment for the inhalation exposure pathway, which will be submitted under a separate cover.
	Air, Inhalation of chemicals entrained in fugitive dust	No	The Final Focused Field Investigation summarizes the sampling results and provides a risk assessment for the inhalation exposure pathway, which will be submitted under a separate cover.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 655.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 655.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	Yes	The Final Focused Field Investigation summarizes the sampling results and provides a risk assessment for the inhalation exposure pathway, which will be submitted under a separate cover.
	Air, Inhalation of chemicals entrained in fugitive dust	No	The Final Focused Field Investigation summarizes the sampling results and provides a risk assessment for the inhalation exposure pathway, which will be submitted under a separate cover.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	The shallow water-bearing zones could hypothetically be used as a potable water source.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Risk-based screening was performed on shallow groundwater data. No VOCs were identified as shallow groundwater COPCs at this site. Therefore, VOCs were not addressed further.

Table 6.2.8.7
Exposure Pathways Summary — AOC 655
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina City Limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.8.8
Statistical Analysis of COPCs
Surface Soils at AOC 655
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Aroclor-1254	14	3.54	0.81	2.501	0.084	0.11	0.084	UCL used	NA	0.084
Aroclor-1260	14	3.91	1.3	3.332	0.386	0.61	0.386	UCL used	NA	0.386
Benzo(a)pyrene Equivalents	10	6.32	0.67	2.483	1.211	3.5907	1.211	UCL used	1	1.211
Dieldrin	14	0.93	1.62	3.941	0.055	0.36	0.055	UCL used	NA	0.055

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
TEF toxic equivalency factor
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 6.2.8.9
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	NA	0.084	1.15E-07	1.07E-06	1.31E-07	4.11E-08	1.47E-08
Aroclor-1260	NA	0.386	5.29E-07	4.94E-06	6.05E-07	1.89E-07	6.75E-08
Benzo(a)pyrene Equivalents	1	1.21	1.66E-06	1.55E-05	1.90E-06	5.92E-07	2.12E-07
Dieldrin	NA	0.0553	7.58E-08	7.07E-07	8.66E-08	2.71E-08	9.66E-09

NOTES:

TEF toxic equivalency factor relative to Benzo(a)pyrene
lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF and reported as Benzo(a)pyrene Equivalents

Table 6.2.8.10
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	NA	0.084	0.01	4.71E-08	1.56E-07	2.95E-08	3.37E-08	1.20E-08
Aroclor-1260	NA	0.386	0.01	2.17E-07	7.16E-07	1.36E-07	1.55E-07	5.53E-08
Benzo(a)pyrene Equivalents	1	1.21	0.01	6.80E-07	2.24E-06	4.26E-07	4.86E-07	1.73E-07
Dieldrin	NA	0.055	0.01	3.11E-08	1.03E-07	1.94E-08	2.22E-08	7.92E-09

NOTES:

TEF Toxic Equivalency Factor relative to benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF and reported as Benzo(a)pyrene Equivalents

Table 6.2.8.11
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Arsenic	0.0423	1.16E-03	2.70E-03	6.37E-04	4.14E-04	1.48E-04
Chlordane	0.0001	2.74E-06	6.39E-06	1.51E-06	9.78E-07	3.49E-07

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake
Chlordane both alpha and gamma isomer concentrations were combined for assessment.

ıle 6.2.8.12 - AOC 655
‹icological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

emical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation
;enic	0.0003	a	M	hyperpigmentation	3	ND			ND
ːldrin	5E-05	a	M	liver lesions	100	ND			ND
B Aroclor-1254	2E-05	a	NA		ND	ND			ND
B Aroclor-1260	ND				ND	ND			ND
nzo(a)pyrene Equivalents	ND				ND	ND			ND
ʼlordane	6E-05	a	L	liver hypertrophy		ND			ND

NOTES:

a Integrated Risk Information System (IRIS)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

able 6.2.8.12 - AOC 655
oxicological Database Information
r Chemicals of Potential Concern
AVBASE Charleston, Zone H

Carcinogenic Toxicity Data

hemical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
rsenic	1.5	a	15.1	a	A	various
eldrin	16	a	16.1	a	B2	hepatoma
CB Aroclor-1254	7.7		ND		B2	hepatocellular carcinoma
CB Aroclor-1260	7.7		ND		B2	hepatocellular carcinoma
enzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
hlordane	1.3	a	ND		B2	liver carcinoma

Table 6.2.8.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	2E-05	7.7	0.0057	0.054	1.0E-06	0.002	1.1E-07
Aroclor-1260	NA	7.7	ND	ND	4.7E-06	ND	5.2E-07
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	1.4E-05	ND	1.5E-06
Dieldrin	5E-05	16	0.0015	0.014	1.4E-06	0.0005	1.5E-07
SUM Hazard Index/ILCR			0.007	0.07	2E-05	0.003	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.8.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	0.5	1E-05	15.4	0.0047	0.016	4.5E-07	0.0034	1.9E-07
Aroclor-1260	0.5	NA	15.4	ND	ND	2.1E-06	ND	8.5E-07
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	6.2E-06	ND	2.5E-06
Dieldrin	0.5	2.5E-05	32	0.0012	0.0041	6.2E-07	0.00089	2.5E-07
SUM Hazard Index/ILCR				0.006	0.02	9E-06	0.004	4E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.8.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Arsenic	0.0003	1.5	3.9	9.0	9.6E-04	1.4	2.2E-04
Chlordane	6E-05	1.3	0.05	0.1	2.0E-06	0.02	4.5E-07
SUM Hazard Index/ILCR			4	9	1E-03	1	2E-04

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.8.16
Summary of Risk and Hazard-based COCs for AOC 655
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs			
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equiv.	ND	ND	1.4E-05	ND	1.5E-06		2		4
		Dieldrin	0.0015	0.014	1.4E-06	0.0005	1.5E-07		2		
		Aroclor-1254	0.0057	0.054	1.0E-06	0.002	1.1E-07		2		
		Aroclor-1260	ND	ND	4.7E-06	ND	5.2E-07		2		
Soil Ingestion Pathway Total			0.007	0.07	2E-05	0.003	2E-06				
	Dermal Contact	Benzo(a)pyrene Equiv.	ND	ND	4.5E-07	ND	1.9E-07		2		
		Dieldrin	0.0012	0.0041	6.2E-06	0.00089	2.5E-06		2		4
		Aroclor-1254	0.0047	0.016	4.5E-07	0.0034	1.9E-07		2		
		Aroclor-1260	ND	ND	2.1E-06	ND	8.5E-07		2		
Soil Dermal Contact Pathway Total			0.006	0.02	9E-06	0.004	4E-06				
Shallow Groundwater	Ingestion	Arsenic	3.9	9	9.6E-04	1.4	2.2E-04	1	2	3	4
		Chlordane	0.05	0.1	2.0E-06	0.02	4.5E-07		2		
Shallow Groundwater Ingestion Pathway Total			4	9	1E-03	1	2E-04				
Sum of All Pathways			8	18	2E-03	3	5E-04				

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Table 6.2.8.17
Central Tendency Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	NA	0.084	3.84E-08	3.59E-07	1.41E-08	3.60E-08	2.57E-09
Aroclor-1260	NA	0.386	1.77E-07	1.65E-06	6.51E-08	1.66E-07	1.18E-08
Benzo(a)pyrene Equivalents	1	1.21	5.54E-07	5.17E-06	2.04E-07	5.19E-07	3.71E-08
Dieldrin	NA	0.0553	2.53E-08	2.36E-07	9.32E-09	2.37E-08	1.69E-09

NOTES:

TEF toxic equivalency factor relative to Benzo(a)pyrene
lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF and reported as Benzo(a)pyrene Equivalents

Table 6.2.8.18
Central Tendency Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	NA	0.084	0.01	3.15E-08	1.04E-07	6.13E-09	2.95E-08	2.11E-09
Aroclor-1260	NA	0.386	0.01	1.45E-07	4.79E-07	2.82E-08	1.36E-07	9.69E-09
Benzo(a)pyrene Equivalents	1	1.21	0.01	4.55E-07	1.50E-06	8.84E-08	4.25E-07	3.04E-08
Dieldrin	NA	0.055	0.01	2.08E-08	6.85E-08	4.04E-09	1.94E-08	1.39E-09

NOTES:

TEF Toxic Equivalency Factor relative to benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF and reported as Benzo(a)pyrene Equivalents

Table 6.2.8.19
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	2E-05	7.7	0.0019	0.018	1.1E-07	0.002	2.0E-08
Aroclor-1260	NA	7.7	ND	ND	5.0E-07	ND	9.1E-08
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	1.5E-06	ND	2.7E-07
Dieldrin	5E-05	16	0.0005	0.005	1.5E-07	0.0005	2.7E-08
SUM Hazard Index/ILCR			0.002	0.02	2E-06	0.002	4E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.8.20
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	0.5	1E-05	15.4	0.0032	0.010	9.4E-08	0.0029	3.2E-08
Aroclor-1260	0.5	NA	15.4	ND	ND	4.3E-07	ND	1.5E-07
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.3E-06	ND	4.4E-07
Dieldrin	0.5	2.5E-05	32	0.0008	0.0027	1.3E-07	0.00078	4.4E-08
SUM Hazard Index/ILCR				0.004	0.01	2E-06	0.004	7E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.8.21
Central Tendency Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Arsenic	0.0423	4.07E-04	1.81E-03	9.03E-05	3.63E-04	2.59E-05
Chlordane	0.0001	9.62E-07	4.27E-06	2.13E-07	8.57E-07	6.12E-08

NOTES:

lwa	lifetime weighted average
CDI	Chronic Daily Intake
H-CDI	Non-carcinogenic hazard based Chronic Daily Intake
C-CDI	Carcinogenic risk based Chronic Daily Intake
Chlordane	both alpha and gamma isomer concentrations were combined for assessment.
BEHP	bis(2-Ethylhexyl)phthalate

Table 6.2.8.22
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 655
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Arsenic	0.0003	1.5	1.4	6.0	1.4E-04	1.2	3.9E-05
Chlordane	6E-05	1.3	0.02	0.1	2.8E-07	0.01	8.0E-08
SUM Hazard Index/ILCR			1	6	1E-04	1	4E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.8.23
Summary of Risk and Hazard for AOC 655
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.007	0.07	2E-05	0.003	2E-06
	Dermal Contact	0.006	0.02	9E-06	0.004	4E-06
Shallow Groundwater	Ingestion	4	9	1E-03	1	2E-04
Sum of All Pathways		4	9	1E-03	1	2E-04

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 6.2.8.24
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 655 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aroclor-1254	7.7	2E-05	0.08	0.057	0.57	5.7	ND
Aroclor-1260	7.7	NA	0.39	0.057	0.57	5.7	ND
Benzo(a)pyrene Equivalents	7.3	NA	1.21	0.060	0.60	6.0	ND
Dieldrin	16	5E-05	0.06	0.028	0.28	2.8	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.8.25
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 655 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene equivalents	7.3	NA	1.21	0.297	2.97	29.7	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.8.26
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 655 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	ARAR mg/l	Background Concentration mg/l
Arsenic	1.5	0.0003	0.0423	0.0005	0.005	0.01	0.00004	0.0004	0.004	0.05	0.028
Chlordane	1.3	6E-05	0.0001	0.0001	0.001	0.003	0.00005	0.0005	0.005	0.002	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.8.27
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 655 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	ARAR mg/l	Background Concentration mg/l
Arsenic	1.5	0.0003	0.0423	0.003	0.03	0.09	0.0002	0.002	0.02	0.05	0.028

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Hypothetical Site Workers (current land use)

The cumulative ILCR (ingestion and dermal contact) was determined to be 1E-6 or greater for Aroclor-1260 and BEQs. Therefore, these compounds were identified as COCs for surface soil based on their contribution to ILCR. No hazard-based COCs were identified for the site worker scenario.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential RGOs were compared to each reported concentration for each COC identified above. RGOs used for this comparison were calculated based on an ILCR of 1E-6 and/or an HQ of 1.0 (where applicable). Aroclors were detected in all but three of 14 samples with 10 samples having concentrations greater than the residential RGO. The widespread nature of Aroclor impacts suggests some type of past general application. Dieldrin was detected sporadically in surface soil with the maximum concentration reported in sample 655SB007, which was collected northwest of Building 656. This sample did not contain any other COPC, indicating that the presence of dieldrin may not be associated with the same source as Aroclors or other COCs. The only BEQ concentration in excess of the residential RBC was reported in a sample collected immediately adjacent to the south loading dock (SGCSB901). It is likely that the cPAH concentrations reported at this location are associated with vehicle exhaust and oil leakage during loading operations.

Groundwater

Hypothetical Site Residents (future land use)

The carcinogenic COCs identified in shallow groundwater were arsenic and gamma-chlordane based on their contribution to risk/hazard.

Hypothetical Site Workers (current land use)

The sole carcinogenic COC identified in shallow groundwater was arsenic based on its contribution to risk/hazard.

The extent of the COCs identified in shallow groundwater is briefly discussed below. To facilitate this brief discussion of the extent of COC concentrations, residential RGOs were compared to each reported concentration for each COC identified above. RGOs are described in Section 6.2.8.8 of this HHRA. RGOs used for this comparison were calculated based on an ILCR of 1E-6 and/or an HQ of 1.0 (where applicable). Consistent detection of chlordane and arsenic in groundwater increases confidence that project risk/hazard is based on a reasonable approximation of maximum exposure. It should be noted, however, that soil arsenic concentrations at AOC 655 do not differ appreciably from reference concentrations. This indicates no soil source for arsenic. In the absence of a source, no correlation of groundwater impacts to current or past site operations can be shown. Furthermore, no second-quarter arsenic concentration exceeded the corresponding reference concentration.

Chlordane was detected in both soil and groundwater near Building 656, but would not be expected in relation to the 1985 fuel oil release. Chlordane may be associated with general applications around the building foundation. Chlordane was reported in only one well during both quarterly monitoring events (655GW002).

Air (Refer to the FFI Report)

As stated in Section 5.5.4.4 of the FFI, no COCs were identified for this scenario based on the sum ILCR and HI for Building 656. Based on the method used in the HHRA, benzene and methylene chloride would be identified as COCs based on their contribution to ILCR for the future resident inhalation exposure pathway.

6.2.8.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure

6.2.9 Baseline Risk Assessment for AOC 656

6.2.9.1 Site Background and Investigative Approach

AOC 656 was investigated to assess a 1974 petroleum spill between Facility 602 and Building NS-71. Eleven samples were collected from the surface soil interval (0 to 1 foot deep). Table 6.2.9.1 shows each surface soil designation and the list of analytical methods used for each. The number of soil samples differs for various analytes because specific groups of analytes were targeted at certain sample locations, as shown in Table 6.2.9.1. Samples were collected from three shallow monitoring wells, and Tables 6.2.9.2 and 6.2.9.3 list the analytical methods used to analyze groundwater samples.

6.2.9.2 COPC Identification

Soil

Based on the screening comparisons described in Section 6.1.3.4 of this report and shown in Table 6.2.9.4, the focus of this HHRA is on the COPCs: BEQs and manganese. Results of the Wilcoxon rank sum test indicate that the concentrations of no soil inorganic are significantly higher than background in surface soil at AOC 656. TPH was identified in all four surface soil samples analyzed, at concentrations ranging between 81 and 1,900 mg/kg. The concentrations in five of six samples analyzed exceed the NAVBASE soil AL of 100 mg/kg.

The risk-based screening value for manganese shown, in Table 6.2.9.4, was calculated by USEPA using a reference dose based on the ingestion of water. A reference dose based on the ingestion of food is also available, and would be more appropriately applied when calculating screening values for the incidental soil ingestion exposure pathway. An alternative risk-based screening value calculated as outlined in the USEPA Region III document, using food RfD, would exceed the maximum reported manganese concentration for surface soil. Manganese was, however, retained for formal assessment.

Groundwater

As shown in Tables 6.2.9.5 and 6.2.9.6, TEQs were the only COC identified for shallow groundwater at AOC 656.

6.2.9.3 Exposure Assessment

Exposure Setting

The exposure setting at AOC 656 is an area between a convenience store (a building across from the Navy Exchange) and a nearby AST. In 1974, No. 5 fuel oil spilled from a ruptured underground fuel line between Facility 602 (the AST) and Building NS-71 (the convenience store). The ruptured fuel line connected the 8,000-gallon AST to the boiler in Building 71. Current base reuse plans indicate that AOC 656 is within the area scheduled for development as a marine industrial park or as open buffer space.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed in this risk assessment. A current site worker's exposure would be less than that assumed for the hypothetical future site worker scenario because soil contact would be limited. Therefore, future worker assessment is considered to be protective of current site users.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of surface soil. The exposure pathways for future residential land use are the same as those for the future site worker. In addition, the hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Uniform exposure was assumed for all sample locations. Shallow groundwater exposure was assessed relative to ingestion through potable use. No inhalation pathway was analyzed because no volatile COPCs were identified in shallow groundwater. Table 6.2.9.7 justifies exposure pathways assessed in this HHRA.

Exposure Point Concentration

Eleven surface soil samples were analyzed for BAP. Therefore, the lower of the UCL or maximum detected concentration was used for the EPC. Table 6.2.9.8 lists the statistical analyses used to derive the EPCs for surface soil at AOC 656. Fewer than 10 shallow groundwater samples have been collected, and as a result, the maximum concentration of each COPC was used as the EPC for associated pathways. BEQs were detected in only three of 11 surface soil samples collected (656SB001-01, 656SB009-01, and 656SB011-01). Other samples surrounding these impacted samples did not contain any detectable concentrations of these COPCs, although many contained TPH at concentrations above the AL. The three impacted samples were distributed across the approximately 0.25 acre site and could be representative of soil conditions over as much as 50% of the parcel. This distribution was considered an indication that an individual could be exposed during onsite activities at concentrations approximating the computed UCL. As a result, it was not deemed appropriate to derive an FI/FC factor accounting for the areal extent of the contaminants in surface soil.

Quantification of Exposure

Soil

Tables 6.2.9.9 and 6.2.9.10 present the CDIs for the soil ingestion and dermal soil contact pathways, respectively.

Groundwater

Shallow groundwater CDIs for the ingestion pathway are provided in Table 6.2.9.11.

6.2.9.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.4 of this report. Table 6.2.9.12 provided toxicological reference information for each COPC identified in soil and groundwater. Presented below are toxicological profiles on each COPC.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the BAP B2 classification is based on insufficient human data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question, the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is based on no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al. 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.*** USEPA determined RfDs for only two of these compounds: pyrene's RfD_o is 0.03 mg/kg-day, and this RfD is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

Dioxins are chlorinated hydrocarbons that accumulate in fat tissue. Exposure to dioxins, known to be potent mutagens and teratogens, causes burning pain in the tongue, abdomen, and pharynx, chloracne, loss of body weight, degenerative changes to the liver and thymus, and psychiatric disturbances. Chloracne is the primary sign of human exposure (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified dioxins as group B2 carcinogens and determined the SF_o to be 150,000 $(mg/kg\text{-}day)^{-1}$ for 2,3,7,8-TCDD. Equivalent concentrations of other dioxin congeners were calculated based on their corresponding toxic equivalents, as recommended by USEPA.

Manganese is an essential nutrient; however, chronic exposure, 0.8 mg/kg-day, causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaassen, et al., 1986. Dreisbach et al., 1987). Because of the different uptake rates in water and food, USEPA set two oral RfDs — one for water and one for food. These RfDs are 0.005 and 0.14 mg/kg-day, respectively. Inhaling manganese dust causes neurological effects and increased incidence of pneumonia, and an inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS, the classification is based on existing studies that are inadequate to assess the carcinogenicity of manganese. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS, the critical effect of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the modifying factor was 1. The critical effect of this chemical in food in the oral summary are CNS effects. The uncertainty factor was 1 and the modifying factor was 1. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. The uncertainty factor was 1000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

6.2.9.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Tables 6.2.9.13 and 6.2.9.14 present the computed carcinogenic risk and noncarcinogenic HQs associated with the incidental ingestion and dermal contact with surface soil, respectively.

Future Site Residents

The projected ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 656 surface soil is 3E-6. The dermal pathway ILCR is 1E-6. BEQs are the only contributor to ILCR for each pathway. HIs for resident child receptors were below 0.01 for both pathways.

Future Site Workers

Site worker ILCRs are 3E-7 and 5E-7 for the ingestion and dermal contact pathways, respectively. BAP is the only contributor to ILCR for each pathway. HIs were below 0.01 for both pathways assessed relative to future site workers.

Because site worker risk projections did not exceed the most conservative 1E-6 point of departure assuming that all surface soil was accessible for contact exposure, no formal assessment was performed considering the influences of existing site features. Site features, such as buildings or pavement, would not be expected to have a significant influence on potential exposure for future site workers. More important with respect to AOC 656 may be the characteristics of the impacted area. The entire investigative area comprises approximately a quarter acre. Future site workers and residents would likely frequent a larger area during daily activities. The nature of the waste operations that prompted investigation would not be expected to lead to widespread contaminant distribution. As a result, soil contact in the investigative area would represent a small fraction of total daily contact, and mean EPCs could be appreciably lower than those applied.

Groundwater

Exposure to shallow groundwater was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion exposure was considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Table 6.2.9.15 presents the computed carcinogenic risk and noncarcinogenic HQs associated with the potable use ingestion of shallow groundwater.

Future Site Residents

The projected ingestion-related ILCR from shallow groundwater was 8E-6. The only contributors for the pathway were TEQs. No HIs were computed for adult and child residential receptors because no oral reference dose is available for 2,3,7,8-TCDD.

Future Site Workers

The projected ingestion-related ILCR from shallow groundwater was 9E-7, and 2,3,7,8-TCDD was the sole contributor.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 656 or other areas of Zone H. In the absence of a completed exposure pathway, shallow groundwater contamination poses no threat to human health.

COCs Identified

BEQs and TEQs were the only COCs identified at AOC 656. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or an HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is comparatively conservative as USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

Under the traditional risk-based COC trigger provisions, no carcinogenic COCs would be identified under the hypothetical future residential use scenario because the cumulative risk is well below 1E-4. Identified COCs are summarized in Table 6.2.9.16.

Surface Soil

Hypothetical Site Residents (Future Land Use)

Benzo(a)pyrene equivalents were identified as COCs for this scenario based on their contribution to risk/hazard.

Hypothetical Site Workers (Current Land Use)

No COCs were identified for this scenario based on the sum ILCR and HI.

Due to the limited extent of identified soil impacts, graphical presentation of risk projections for AOC 656 surface soil was determined to be of limited use. Instead, the extent of the COCs is briefly discussed below. To facilitate this discussion of extent, residential RGOs were compared to each reported BEQ concentration. RGOs are described in Section 6.2.9.8 of this HHRA and were calculated based on an ILCR of 1E-6. BEQs were detected in excess of the RGO in only three of 11 surface soil samples collected (656SB001-01, 656SB009-01, and 656SB011-01). Other samples surrounding these impacted samples did not contain any detectable concentrations of BEQs, although many contained TPH at concentrations above the AL. The three impacted samples were distributed across the approximately one quarter-acre site and could be representative of soil conditions over as much as 50% of the parcel.

Groundwater

Hypothetical Site Residents

The COCs identified for this scenario based on its contribution to ILCR were TEQs.

Hypothetical Site Workers

No COCs were identified for this scenario based on the sum ILCR and HI.

Due to the limited extent of identified shallow groundwater impacts, graphical presentation of risk projections for AOC 656 groundwater was determined to be of limited use. Instead, the extent of the COCs is briefly discussed below. TEQs were detected in the one first-quarter shallow groundwater sample analyzed for dioxins. Due to the hydrophobic nature of dioxins, they are not expected to migrate from soil to groundwater. It has been suspected that first-quarter results may reflect the influence of sediment entrained in the monitored zone during well installation. Third- and fourth-quarter results will confirm whether TEQs are present in shallow groundwater. This review will facilitate responsible and sound risk management decisions.

6.2.9.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site groundwater. They are infrequently exposed to surface soil when walking across the site, using commercial facilities, or mowing grass. Site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. Mowing grass 52 days per year would result in one-fifth the projected risk/hazard for site workers.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. The reuse plans call for continued commercial/industrial use of Zone H. Specifically, the area including AOC 656 is proposed to become a marine industrial park or remain open buffer space. If this area were to be used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

No site features that would have a significant influence on potential exposure for future site workers. The entire investigative area is only approximately a quarter-acre. Future site workers and residents would likely frequent a larger area during daily activities. The nature of the waste operations that prompted investigation would not be expected to lead to widespread contaminant distribution. As a result, soil contact in the investigative area would represent a small fraction of total daily contact and would mean that mean EPCs could be appreciably lower than those applied.

Shallow groundwater is not currently used at AOC 656 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone H. This system is to remain in operation under the current base reuse plan. As a result, shallow groundwater use would not be expected under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed.

Determination of Exposure Point Concentrations

The UCL of the concentrations reported for BAP was used as the EPC for this site. The maximum detected manganese concentration was applied as the surface soil EPC. Due to the limited shallow groundwater dataset, maximum concentrations were also used as the EPC for COPCs identified in this medium.

Frequency of Detection and Spatial Distribution

BEQs were detected in three of 11 surface soil samples. This limited number of detections was not sufficient basis for deriving an FI/FC factor due to the spatial distributions of the hits. Further delineation would be required to determine whether the UCL concentration computed is representative of less than 50% of the total investigative area. Without this further refinement, application of hot spot assessment methods was considered inappropriate.

Elevated TPH results (81 to 1,900 mg/kg) were reported in six of nine surface soil samples analyzed. No groundwater sample contained detectable concentrations of TPH, indicating that shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of TPH constituents. Five surface soil TPH results exceeded the NAVBASE soil AL of 100 mg/kg.

In groundwater, 2,3,7,8-TCDD was the only COC identified. It was detected in the one first-quarter sample analyzed at a concentration of 1.74E-9 mg/L. Based on this limited dataset, it cannot be definitively determined whether chronic exposure at the EPC applied is a reasonable estimate.

Quantification of Risk/Hazard

As indicated by the discussion above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors that would upwardly bias the risk and hazard estimates have affected the uncertainty of this assessment. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs eliminated from formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSS. Concentrations of aluminum, arsenic, beryllium, chromium, and vanadium exceed corresponding RBCs, but maximum concentrations of these elements do not exceed corresponding reference concentrations. Therefore, they were eliminated from formal assessment based on comparisons to the reference concentrations, because they do not contribute to excess risk/hazard onsite.

Although the future land use at this site is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would overestimate risk and/or hazard. An individual map was not produced for this site.

The cumulative RME risk for surface soil incidental ingestion and dermal contact pathways was computed to be 4E-6 with BEQs as the sole contributors. Although no formal CT was analyzed, a simplified assessment follows. Under CT, exposure duration is assumed to be nine years (versus 30 years under RME) and exposure frequency is assumed to be 234 days/year (versus 350 days/year under RME). Due to the linear relationship between exposure frequency and duration, and ultimately projected risk, it was calculated that under CT assumptions the cumulative soil pathway ILCR would be reduced by a factor of 5. The resultant CT ILCR projection would fall below the most conservative 1E-6 point of departure.

Groundwater

TEQs, the sole shallow groundwater COCs, were detected at a maximum concentration of 1.74E-9 mg/L in one first-quarter sample. This maximum concentration is below the ARAR of 3E-8 mg/L.

Of the CPSSs eliminated from the formal assessment because they do not exceed the corresponding RBCs, none was reported at a concentration within 10% its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs.

Although the future land use at this site is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard. An individual map was not produced for this site.

The CT assumption for residential exposure duration is nine years compared to the 30-year assumption for RME. If all other exposure assumptions remain fixed, application of the CT exposure duration would result in risk projections 66% below the RME presented in Table 6.2.9.16. At CT, the shallow groundwater-related risk (incidental ingestion) would be approximately 1.3E-6, which still exceeds the SCDHEC point of departure.

6.2.9.7 Risk Summary

The risk and hazard posed by contaminants at AOC 656 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion was the sole pathway evaluated relative to shallow groundwater. Table 6.2.9.17 summarizes risks for each pathway/receptor group evaluated for AOC 656.

6.2.9.8 Remedial Goal Options

Soil

RGOs were calculated for the future site resident based on the RME risk estimates presented in Section 6.2.9.5, and are presented in Table 6.2.9.18.

Groundwater

RGOs for the shallow aquifer were calculated for future residents, as provided in Table 6.2.9.19. 2,3,7,8-TCDD was the sole COC for which RGOs were calculated, and it should be noted that the maximum reported concentration is below the ARAR MCL (3E-8 mg/L).

Table 6.2.9.1
Methods Run at AOC 656
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
656	B001	S	S	S	Y					S	Y					
656	B002	B	B	B	Y	Y	Y	Y	A	B	B					
656	B003	S	S	S	Y					S	Y					
656	B004	S	S	S	Y					S	Y					
656	B005	S	S	S	Y					S	Y					
656	B006	S	S	S	Y					S	Y					
656	B007	S	S	S	Y					S	Y					
656	B008	S	S	S	Y					S	Y					
656	B009	B	B	B	Y	Y	Y	Y	A	B	B					
656	B010		S													
656	B011		S													
656	B01A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195	Wq I:	Wet Chemistry I Parameters
Dioxin:	Dioxins: Method 8290	Wq II	Wet Chemistry II Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Phys:	Physical Chemistry Parameters
Herb:	Chlorinated Herbicides: Method 8150		

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.9.2
Methods Run at AOC 656
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
656	W001	B	B	B	Y	Y	Y	Y	A	B	B					
656	W002	S	S	S	Y					S	Y					
656	W003	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.9.3
Methods Run at AOC 656
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
656	W001	S		S												
656	W002	S		S												
656	W003	S		S												

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.9.4
AOC 656
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/KG	1/ 11	330.00 - 2400.00	180.000 - 180.000	180.000	470000.0000			
Aluminum	MG/KG	9/ 9		1940.000 - 17400.000	5757.777	7800.0000	2	25310.000	
Anthracene	UG/KG	1/ 11	330.00 - 2400.00	250.000 - 250.000	250.000	2300000.0000			
Arsenic	MG/KG	9/ 9		0.565 - 14.800	5.890	0.3700	9	14.810	
Barium	MG/KG	4/ 9	7.00 - 9.00	7.800 - 25.800	15.825	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	2/ 11	330.00 - 2400.00	127.000 - 240.000	183.500	310000.0000r			
* Benzo(a)pyrene Equivalents	UG/KG	11/ 11		91.132 - 593.880	155.325	88.0000	11		
Benzo(a)anthracene	UG/KG	3/ 11	330.00 - 2400.00	163.000 - 620.000	317.666				
Benzo(b)fluoranthene	UG/KG	3/ 11	330.00 - 2400.00	130.000 - 430.000	246.333				
Chrysene	UG/KG	3/ 11	330.00 - 2400.00	164.000 - 580.000	324.666				
Indeno(1,2,3-cd)pyrene	UG/KG	2/ 11	330.00 - 2400.00	111.000 - 240.000	175.500				
Benzo(k)fluoranthene	UG/KG	3/ 11	330.00 - 2400.00	170.000 - 430.000	256.666				
Benzo(a)pyrene	UG/KG	3/ 11	330.00 - 2400.00	140.000 - 460.000	253.666				
Beryllium	MG/KG	4/ 9	0.08 - 0.23	0.030 - 0.920	0.427	0.1500	3	1.470	
Calcium	MG/KG	9/ 9		3190.000 - 48800.000	13787.777				
alpha-Chlordane	UG/KG	4/ 9	4.00 - 5.00	1.800 - 6.000	3.300	470.0000			
gamma-Chlordane	UG/KG	4/ 9	4.00 - 5.00	1.100 - 6.000	3.475	470.0000			
Chromium	MG/KG	9/ 9		5.650 - 41.800	15.961	39.0000	1	85.650	
Cobalt	MG/KG	3/ 9	0.61 - 3.40	0.340 - 5.500	2.446	470.0000		5.860	
Copper	MG/KG	9/ 9		1.900 - 27.800	11.816	290.0000		27.600	1
4,4'-DDE	UG/KG	3/ 9	3.30 - 5.00	3.000 - 10.000	6.000	1900.0000			
4,4'-DDT	UG/KG	1/ 9	3.30 - 10.00	2.700 - 2.700	2.700	1900.0000			
Dioxin (TCDD TEQ)	PG/G	2/ 2		1.390 - 4.887	3.138	1000.0000			
Endosulfan II	UG/KG	1/ 9	3.30 - 10.00	3.200 - 3.200	3.200	47000.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	1/ 11	330.00 - 2400.00	280.000 - 280.000	280.000	46000.0000			
Fluoranthene	UG/KG	5/ 11	420.00 - 2400.00	120.000 - 1300.000	430.400	310000.0000			
Fluorene	UG/KG	1/ 11	330.00 - 2400.00	180.000 - 180.000	180.000	310000.0000			
Iron	MG/KG	9/ 9		1550.000 - 27500.000	8483.333			30910.000	
Lead	MG/KG	3/ 9	6.80 - 22.90	34.900 - 40.000	37.433	400.0000i		118.000	
Magnesium	MG/KG	9/ 9		141.000 - 3460.000	1112.333			9592.000	
* Manganese	MG/KG	9/ 9		8.800 - 719.000	170.722	39.0000	7	636.400	1
Mercury	MG/KG	5/ 9	0.02 - 0.06	0.040 - 0.260	0.153	2.3000		0.490	
Nickel	MG/KG	4/ 9	1.40 - 4.50	0.880 - 12.800	7.820	160.0000		33.380	
Phenanthrene	UG/KG	4/ 11	420.00 - 2400.00	100.000 - 1100.000	417.750	310000.0000k			

Table 6.2.9.4
AOC 656
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Potassium	MG/KG	2/ 9	88.40 -	598.00	753.000 -	1650.000	1201.500				
Pyrene	UG/KG	5/ 11	420.00 -	2400.00	92.000 -	970.000	331.100	230000.0000			
Selenium	MG/KG	3/ 9	0.22 -	0.39	0.110 -	0.720	0.350	39.0000		2.000	
Sodium	MG/KG	9/ 9			48.600 -	696.000	216.688				
2,4,5-TP (Silvex)	UG/KG	2/ 2			7.300 -	8.400	7.850	63000.0000			
* Petroleum Hydrocarbons, TPH	MG/KG	6/ 9	69.00 -	74.00	81.000 -	1900.000	621.833	10.0000	6		
Tin	MG/KG	1/ 2	1.30 -	1.30	5.800 -	5.800	5.800	4700.0000			
Vanadium	MG/KG	9/ 9			2.900 -	56.100	19.250	55.0000	1	77.380	
Zinc	MG/KG	7/ 9	10.90 -	14.60	3.900 -	306.700	98.385	2300.0000		214.300	1

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.9.5
AOC 656
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	UG/L	1/ 3	15.10 - 15.10	672.000 - 672.000	672.000	3700.0000			
Arsenic	UG/L	1/ 3	2.10 - 4.30	18.000 - 18.000	18.000	0.0380	1	27.990	
Barium	UG/L	2/ 3	10.30 - 10.30	8.400 - 55.400	31.900	260.0000		323.000	
Calcium	UG/L	3/ 3		75700.000 - 257000.000	137833.333				
* Dioxin (TCDD TEQ)	PG/L	1/ 1		1.747 - 1.747	1.747	0.5000	1		
123678-HxCDF	PG/L	1/ 1		1.383 - 1.383	1.383				
OCDD	PG/L	1/ 1		18.711 - 18.711	18.711				
OCDF	PG/L	1/ 1		3.181 - 3.181	3.181				
12378-PeCDD	PG/L	1/ 1		3.014 - 3.014	3.014				
12378-PeCDF	PG/L	1/ 1		1.590 - 1.590	1.590				
Iron	UG/L	3/ 3		3650.000 - 17900.000	9716.666				
Magnesium	UG/L	3/ 3		58100.000 - 717000.000	277900.000				
Manganese	UG/L	3/ 3		153.000 - 454.000	260.333	18.0000	3	3391.000	
Potassium	UG/L	3/ 3		35700.000 - 172000.000	82533.333				
Sodium	UG/L	3/ 3		479000.000 - 5330000.000	2108333.333				
Vanadium	UG/L	1/ 3	3.50 - 3.50	4.600 - 4.600	4.600	26.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.9.6
AOC 656
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	UG/L	2/ 3	15.40 - 15.40	33.900 - 206.000	119.950	3700.0000			
Arsenic	UG/L	2/ 3	2.60 - 2.60	2.600 - 3.050	2.825	0.0380	2	27.990	
Barium	UG/L	3/ 3		9.300 - 83.000	35.033	260.0000		323.000	
Calcium	UG/L	3/ 3		69700.000 - 298000.000	152433.333				
Chromium	UG/L	1/ 3	2.00 - 2.00	2.000 - 2.000	2.000	18.0000			
Iron	UG/L	3/ 3		4360.000 - 23100.000	11060.000				
Magnesium	UG/L	3/ 3		53800.000 - 894000.000	340233.333				
Manganese	UG/L	3/ 3		127.500 - 835.000	408.166	18.0000	3	3391.000	
Nickel	UG/L	1/ 3	5.50 - 5.50	27.500 - 27.500	27.500	73.0000			
Potassium	UG/L	3/ 3		31250.000 - 222000.000	96750.000				
Sodium	UG/L	3/ 3		480000.000 - 6230000.000	2421333.333				
Thallium	UG/L	1/ 3	3.30 - 3.70	4.100 - 4.100	4.100	0.2900	1	7.660	
Vanadium	UG/L	3/ 3		2.700 - 11.600	5.733	26.0000			
Zinc	UG/L	1/ 3	5.80 - 5.80	18.500 - 18.500	18.500	1100.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.9.7
Exposure Pathways Summary — AOC 656
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 656.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 656.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	CPSSs were greater than RBC and Reference concentrations.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	No significant VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.

Table 6.2.9.7
Exposure Pathways Summary — AOC 656
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.9.8
Statistical Analysis of COPCs
Surface Soils at AOC 656
Naval Base Charleston Zone H
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)		TEF	Adjusted EPC (mg/kg)
Benzo(a)pyrene Equivalents	11	4.82	0.6	2.32	0.230	0.594	0.230	UCL used	1	0.230
Manganese	9	NA	NA	NA	NA	719	719	MAX used	NA	719

NOTES:

- mean arithmetic mean of the logtransformed data
- n number of samples analyzed
- SD standard deviation for a sample of data
- H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
- NA not applicable
- TEF toxic equivalency factor
- EPC exposure point concentration
- UCL 95 percentile upper confidence level mean
- MAX maximum reported concentration

Table 6.2.9.9
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 656
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.1	0.23	3.16E-07	2.95E-06	3.61E-07	1.13E-07	4.03E-08
Manganese	NA	719.00	9.85E-04	9.19E-03	1.13E-03	3.52E-04	1.26E-04

NOTES:

TEF	toxic equivalency factor relative to Benzo(a)pyrene
lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
-	exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.9.10
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 656
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.230	0.01	1.29E-07	4.27E-07	8.10E-08	9.25E-08	3.30E-08
Manganese	NA	719.00	0.001	4.04E-05	1.33E-04	2.53E-05	2.88E-05	1.03E-05

NOTES:

TEF Toxic Equivalency Factor relative to benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.9.11
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 656
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
2,3,7,8-TCDD Equivalents	1.74E-09	4.77E-11	1.11E-10	2.62E-11	1.70E-11	6.08E-12

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

able 6.2.9.12 - AOC 656
oxicological Database Information
r Chemicals of Potential Concern
AVBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

hemical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation
anganese (water)	0.005	a	NA	neurological effects	1	1.43E-05	a	M	neurological effects	1000
anganese (food)	0.14	a	NA	neurological effects	1	ND				ND
enzo(a)pyrene Equivalents	ND				ND	ND				ND
3,7,8-TCDD	ND				ND	ND				ND

NOTES:

a Integrated Risk Information System (IRIS)
b Health Effects Assessment Summary Tables (HEAST)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

ble 6.2.9.12 - AOC 656
xicological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Carcinogenic Toxicity Data

emical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
nganese (water)	ND		ND		D	
nganese (food)	ND		ND		D	
nzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
,7,8-TCDD	150000	b			B2	mutagen and teratogen

Table 6.2.9.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 656
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.6E-06	ND	2.9E-07
Manganese	0.14	NA	0.01	0.07	ND	0.003	ND
SUM Hazard Index/ILCR			0.01	0.07	3E-06	0.003	3E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.9.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 656
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.2E-06	ND	4.8E-07
Manganese	0.2	0.028	NA	0.001	0.005	ND	0.001	ND
SUM Hazard Index/ILCR				0.001	0.005	1E-06	0.001	5E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.9.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 656
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
2,3,7,8-TCDD Equivalents	NA	150000	ND	ND	3.9E-06	ND	9.1E-07
SUM Hazard Index/ILCR			ND	ND	4E-06	ND	9E-07

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime excess Cancer Risk

Table 6.2.9.16
Summary of Risk and Hazard-based COCs for AOC 656
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway		HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)	Child HQ	Resid. ILCR	Worker HQ	Worker ILCR
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equiv.	0.01	0.07	3E-06	0.003	3E-07		2		
	Dermal Contact	Benzo(a)pyrene Equiv.	0.001	0.005	1E-06	0.001	5E-07		2		
Shallow Groundwater	Ingestion	2,3,7,8-TCDD Equiv.	ND	ND	4E-06	ND	9E-07		2		
Sum of All Pathways			0.011	0.075	8E-06	0.004	2E-06				

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Table 6.2.9.17
Summary of Risk and Hazard for AOC 656
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.01	0.07	3E-06	0.003	3E-07
	Dermal Contact	0.001	0.005	1E-06	0.001	5E-07
Shallow Groundwater	Ingestion	ND	ND	4E-06	ND	9E-07
Sum of All Pathways		0.011	0.075	8E-06	0.004	2E-06

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 6.2.9.18
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 656 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 10 mg/kg	1.0 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	0.230	NA	NA	NA	0.060	0.60	6.0	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.9.19
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 656 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	**Risk-Based Remedial Goal Options** **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	Background Concentration mg/l
2,3,7,8-TCDD Equivalents	150000	NA	1.74E-09	4.4E-10	4.4E-09	4.4E-08	3E-08	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

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6.2.10 Baseline Risk Assessment for AOC 659

6.2.10.1 Site Background and Investigative Approach

AOC 659 was investigated to assess soil potentially affected by past site activities. This 30,000-gallon AST south of Hobson Avenue surrounded by a 5-foot high earthen berm. The AOC, which was used to store diesel fuel from 1958 until 1990, is no longer in use. Four surface soil samples were collected and analyzed at AOC 659. Table 6.2.10.1 shows each surface soil designation and the list of analytical methods used for each. Groundwater was not samples at this site.

6.2.10.2 COPC Identification

Surface soil data and screening values used in the screening comparison of AOC 659 soil are summarized in Table 6.2.10.2. As shown in the tables, no COPCs were identified. Therefore, no formal assessment of surface soil was warranted. Petroleum hydrocarbons were identified in three of four soil samples, at concentrations ranging from 77 to 180 mg/kg. The maximum concentration exceeds the soil action level of 100 mg/kg established for NAVBASE.

Table 6.2.10.1
Methods Run at AOC 659
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
659	B001	B	B	B	Y	Y	Y	Y	A	B	B					
659	B002	S	S	S	Y					S	Y					
659	B003	S	S	S	Y					S	Y					
659	B004	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6-2.10.2
AOC 659
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	1/ 4	30.00 - 31.00	8.750 - 8.750	8.750	780000.0000			
Aluminum	MG/KG	4/ 4		2310.000 - 6870.000	4717.500	7800.0000		25310.000	
Arsenic	MG/KG	4/ 4		0.610 - 2.300	1.577	0.3700	4	14.810	
Barium	MG/KG	2/ 4	5.50 - 7.20	6.400 - 8.600	7.500	550.0000		40.330	
Beryllium	MG/KG	2/ 4	0.03 - 0.04	0.160 - 0.210	0.185	0.1500	2	1.470	
Cadmium	MG/KG	1/ 4	0.16 - 0.19	0.220 - 0.220	0.220	3.9000		1.050	
Calcium	MG/KG	4/ 4		550.000 - 58600.000	15524.500				
alpha-Chlordane	UG/KG	1/ 4	3.60 - 3.80	1.300 - 1.300	1.300	470.0000			
gamma-Chlordane	UG/KG	2/ 4	3.70 - 3.80	3.800 - 10.000	6.900	470.0000			
Chromium	MG/KG	3/ 4	2.10 - 2.10	4.200 - 18.400	10.700	39.0000		85.650	
Cobalt	MG/KG	2/ 4	0.28 - 0.33	1.000 - 1.000	1.000	470.0000		5.860	
4,4'-DDT	UG/KG	1/ 4	7.10 - 7.50	3.600 - 3.600	3.600	1900.0000			
Di-n-butylphthalate	UG/KG	1/ 4	400.00 - 420.00	52.000 - 52.000	52.000	780000.0000			
Dieldrin	UG/KG	1/ 4	4.00 - 4.20	2.700 - 2.700	2.700	40.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1		0.738 - 0.738	0.738	1000.0000			
Endosulfan sulfate	UG/KG	1/ 4	7.10 - 7.50	2.400 - 2.400	2.400	47000.0000g			
bis(2-Ethylhexyl)phthalate	UG/KG	2/ 4	400.00 - 420.00	106.000 - 423.000	264.500	46000.0000			
Iron	MG/KG	4/ 4		1610.000 - 4290.000	3112.500			30910.000	
Lead	MG/KG	4/ 4		2.400 - 12.100	6.425	400.0000j		118.000	
Magnesium	MG/KG	4/ 4		36.900 - 1820.000	591.725			9592.000	
Manganese	MG/KG	4/ 4		4.500 - 38.700	21.750	39.0000		636.400	
Mercury	MG/KG	1/ 4	0.03 - 0.03	0.080 - 0.080	0.080	2.3000		0.490	
Nickel	MG/KG	1/ 4	1.60 - 7.60	0.770 - 0.770	0.770	160.0000		33.380	
Sodium	MG/KG	3/ 4	12.80 - 12.80	16.400 - 271.000	109.066				
2,4,5-T	UG/KG	1/ 1		9.000 - 9.000	9.000	78000.0000			
2,4,5-TP (Silvex)	UG/KG	1/ 1		9.100 - 9.100	9.100	63000.0000			
• Petroleum Hydrocarbons, TPH	MG/KG	3/ 4	71.00 - 71.00	77.000 - 180.000	139.000	10.0000	3		
Tin	MG/KG	1/ 1		1.500 - 1.500	1.500	4700.0000			
Toluene	UG/KG	1/ 4	6.00 - 6.30	1.500 - 1.500	1.500	1600000.0000			
Vanadium	MG/KG	4/ 4		4.150 - 16.600	9.862	55.0000		77.380	
Zinc	MG/KG	2/ 4	3.90 - 4.40	15.200 - 30.700	22.950	2300.0000		214.300	

Notes:

- • Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- g Endosulfan used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water

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6.2.11 Baseline Risk Assessment for AOC 660

6.2.11.1 Site Background and Investigative Approach

AOC 660 was investigated to assess potential soil and groundwater impacts associated with site activities. AOC 660, which is currently an asphalt parking lot northwest of Building NS-53, was used for mosquito control staff operations in the 1950s. It may have been used to store, mix, and rinse pesticides and application equipment. In all, eight surface soil samples were collected and analyzed at AOC 660. Table 6.2.11.1 shows each surface soil sample designation and lists the analytical methods used for each sample. Groundwater samples were collected from two shallow monitoring wells and analyzed for a similar list of parameters. First- and second-quarter groundwater data used as the basis for this HHRA are listed in Tables 6.2.11.2. and 6.2.11.3.

6.2.11.2 COPC Identification

Soil

Surface soil data and screening values used in the screening comparison for AOC 660 soil are summarized in Table 6.2.11.4. As shown in the tables, no COPCs were identified. In addition, the results of Wilcoxon rank sum test background comparisons of inorganic CPSSs that exceeded their corresponding risk-based screening values did not identify any COPCs. Therefore, no formal assessment of surface soil was warranted. TPH was not identified in any surface soil samples.

Groundwater

Shallow groundwater data and screening values used in the screening comparisons for AOC 660 groundwater are summarized in Tables 6.2.11.5 and 6.2.11.6 for first-and second-quarter results. No groundwater COPCs were identified at AOC 660 based on first- or second-quarter sampling results. In addition, the results of Wilcoxon rank sum test background comparisons of inorganic CPSSs that exceeded their corresponding risk-based screening values did not identify any COPCs. Therefore, shallow groundwater was not assessed formally.

Table 6.2.11.1
Methods Run at AOC 660
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
660	B001	S	S	S	Y					S						
660	B002	S	S	S	Y					S						
660	B003	S	S	S	Y					S						
660	B004	S	S	S	Y					S						
660	B005	B	B	B	Y	Y	Y	Y	A	B	A					
660	B006	S	S	S	Y					S						
660	B007	S	S	S	Y					S						
660	B008	S	S	S	Y					S						

METHODS:

Metal: TAL (Target Analyte List) Metals plus tin:
Methods: 6000/7000 Series
VOA: Volatile Organics: Method 8240
SVOA: Semi-volatile Organics: Method 8270
Cn: Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac: Hexavalent Chromium: Method 7195
Dioxin: Dioxins: Method 8290
Oppe: Organophosphate Pesticides: Method 8140
Herb: Chlorinated Herbicides: Method 8150
Pest: Chlorinated Pesticides: Method 8080
Tph: Total Petroleum Hydrocarbons: Method 418.1
Tph GR: Total Petroleum Hydrocarbons with Gasoline Range Organics
Extraction Method 5030, GC Method 8015
Tph DR: Total Petroleum Hydrocarbons with Diesel Range Organics
Extraction Method 3550, GC Method 8100
Wq I: Wet Chemistry I Parameters
Wq II: Wet Chemistry II Parameters
Phys: Physical Chemistry Parameters

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.11.2
Methods Run at AOC 660
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
660	W001	S	S	S	Y					S	Y					
660	W002	S	S	S	Y					S	Y					

METHODS:

Metal: TAL (Target Analyte List) Metals plus tin:
Methods: 6000/7000 Series
VOA: Volatile Organics: Method 8240
SVOA: Semi-volatile Organics: Method 8270
Cn: Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac: Hexavalent Chromium: Method 7195
Dioxin: Dioxins: Method 8290
Oppe: Organophosphate Pesticides: Method 8140
Herb: Chlorinated Herbicides: Method 8150
Pest: Chlorinated Pesticides: Method 8080
Tph: Total Petroleum Hydrocarbons: Method 418.1
Tph GR: Total Petroleum Hydrocarbons with Gasoline Range Organics
Extraction Method 5030, GC Method 8015
Tph DR: Total Petroleum Hydrocarbons with Diesel Range Organics
Extraction Method 3550, GC Method 8100
Wq I: Wet Chemistry I Parameters
Wq II Wet Chemistry II Parameters
Phys: Physical Chemistry Parameters

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.11.3
Methods Run at AOC 660
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
660	W001	S								S						
660	W002	S								S						

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.11.4
AOC 660
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	2/ 8	28.00 - 150.00	23.000 - 73.700	48.350	780000.0000			
Aluminum	MG/KG	8/ 8		2290.000 - 9550.000	5683.750	7800.0000	1	25310.000	
Arsenic	MG/KG	4/ 8	0.48 - 1.60	0.410 - 1.600	0.870	0.3700	4	14.810	
Barium	MG/KG	3/ 8	4.40 - 18.60	4.100 - 20.000	10.366	550.0000		40.330	
Beryllium	MG/KG	4/ 8	0.03 - 0.36	0.080 - 0.450	0.182	0.1500	1	1.470	
2-Butanone (MEK)	UG/KG	1/ 8	10.00 - 29.00	4.100 - 4.100	4.100	4700000.0000			
Calcium	MG/KG	7/ 8	1.00 - 1.00	3450.000 - 118000.000	24404.285				
alpha-Chlordane	UG/KG	1/ 8	1.70 - 4.00	4.000 - 4.000	4.000	470.0000			
gamma-Chlordane	UG/KG	2/ 8	1.70 - 4.00	4.000 - 4.000	4.000	470.0000			
Chromium	MG/KG	4/ 8	3.20 - 19.80	3.300 - 9.600	6.150	39.0000		85.650	
Cobalt	MG/KG	4/ 8	0.70 - 8.90	0.420 - 4.900	1.787	470.0000		5.860	
Copper	MG/KG	8/ 8		0.490 - 4.400	2.138	290.0000		27.600	
4,4'-DDD	UG/KG	5/ 8	7.00 - 8.00	5.000 - 12.000	8.210	2700.0000			
4,4'-DDE	UG/KG	8/ 8		3.000 - 62.000	13.618	1900.0000			
4,4'-DDT	UG/KG	3/ 8	7.00 - 8.00	4.000 - 12.000	6.833	1900.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1		2.611 - 2.611	2.611	1000.0000			
Endrin aldehyde	UG/KG	1/ 8	3.30 - 8.00	7.000 - 7.000	7.000	2300.0000h			
Heptachlor	UG/KG	1/ 8	1.70 - 4.00	4.000 - 4.000	4.000	140.0000			
Iron	MG/KG	8/ 8		452.000 - 2530.000	1363.625			30910.000	
Lead	MG/KG	4/ 8	2.10 - 3.90	2.200 - 27.000	9.675	400.0000j		118.000	
Magnesium	MG/KG	4/ 8	69.10 - 210.00	105.000 - 663.000	335.000			9592.000	
Manganese	MG/KG	4/ 8	2.30 - 11.00	8.400 - 73.000	39.950	39.0000	2	636.400	
Mercury	MG/KG	4/ 8	0.02 - 0.07	0.020 - 0.120	0.055	2.3000		0.490	
Nickel	MG/KG	3/ 8	0.72 - 2.30	0.860 - 1.400	1.056	160.0000		33.380	
Selenium	MG/KG	1/ 8	0.31 - 0.97	0.400 - 0.400	0.400	39.0000		2.000	
Sodium	MG/KG	4/ 8	48.00 - 86.20	108.000 - 298.000	200.000				
2,4,5-TP (Silvex)	UG/KG	1/ 1		8.600 - 8.600	8.600	63000.0000			
Thallium	MG/KG	1/ 8	0.26 - 0.97	0.350 - 0.350	0.350	0.6300		0.630	
Tin	MG/KG	1/ 1		2.900 - 2.900	2.900	4700.0000			
Toluene	UG/KG	3/ 8	5.00 - 6.00	3.500 - 9.000	5.500	1600000.0000			
Toxaphene	UG/KG	1/ 8	100.00 - 200.00	100.000 - 100.000	100.000	800.0000			
Vanadium	MG/KG	4/ 8	3.00 - 14.60	3.700 - 11.400	6.625	55.0000		77.380	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- h Endrin used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water

Table 6.2.11.5
AOC 660
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	UG/L	2/ 2			18.300 -	25.800	22.050	3700.0000			
Barium	UG/L	2/ 2			1.900 -	8.300	5.100	260.0000		323.000	
Calcium	UG/L	2/ 2			60900.000 -	122000.000	91450.000				
Iron	UG/L	2/ 2			625.000 -	1800.000	1212.500				
Magnesium	UG/L	2/ 2			23900.000 -	31300.000	27600.000				
Manganese	UG/L	2/ 2			49.600 -	73.600	61.600	18.0000	2	3391.000	
Potassium	UG/L	2/ 2			21200.000 -	22600.000	21900.000				
Silver	UG/L	1/ 2	2.70 -	2.70	3.500 -	3.500	3.500	18.0000			
Sodium	UG/L	2/ 2			51300.000 -	91500.000	71400.000				

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.11.6
AOC 660
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	UG/L	1/ 2	15.40 - 15.40	1940.000 - 1940.000	1940.000	3700.0000			
Arsenic	UG/L	1/ 2	2.60 - 2.60	12.800 - 12.800	12.800	0.0380	1	27.990	
Barium	UG/L	2/ 2		4.700 - 17.900	11.300	260.0000		323.000	
Calcium	UG/L	2/ 2		55700.000 - 133000.000	94350.000				
Chromium	UG/L	1/ 2	2.00 - 2.00	2.750 - 2.750	2.750	18.0000			
Iron	UG/L	2/ 2		556.000 - 5695.000	3125.500				
Magnesium	UG/L	2/ 2		23800.000 - 28600.000	26200.000				
Manganese	UG/L	2/ 2		62.100 - 108.500	85.300	18.0000	2	3391.000	
Potassium	UG/L	2/ 2		18250.000 - 19300.000	18775.000				
Sodium	UG/L	2/ 2		45000.000 - 66500.000	55750.000				
Vanadium	UG/L	2/ 2		2.600 - 7.600	5.100	26.0000			
Zinc	UG/L	1/ 2	5.80 - 5.80	8.600 - 8.600	8.600	1100.0000			

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

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6.2.12 Baseline Risk Assessment for AOC 662

6.2.12.1 Site Background and Investigative Approach

AOC 662 was investigated to assess potential soil and groundwater impacts associated with site activities. AOC 662 was a service station from 1958 until it was converted to storage space at an unknown date. It is currently a nonhazardous material storage area. It is possible that two unregistered, steel USTs may be onsite. Four surface soil samples were collected and analyzed at AOC 662. Table 6.2.12.1 shows surface soil sample designations and lists of analytical methods used for each corresponding sample. Groundwater samples were collected from two shallow monitoring wells and analyzed for a similar list of parameters. First- and second-quarter groundwater data were used as the basis for this HHRA. Groundwater samples are listed in Tables 6.2.12.2 and 6.2.12.3 for the first and second quarter.

6.2.12.2 COPC Identification

Soil

Surface soil data and screening values used in the screening comparison for AOC 662 soil are summarized in Table 6.2.12.4. As shown in the tables, no COPCs were identified. In addition, the results of Wilcoxon rank sum test background comparisons of inorganic CPSSs that exceeded their corresponding risk-based screening values did not identify any COPCs. Therefore, no formal assessment of surface soil was warranted. TPH was not identified in any surface soil samples.

Groundwater

Shallow groundwater data and screening values used in the screening comparisons for AOC 662 groundwater are summarized in Tables 6.2.12.5 and 6.2.12.6 for first- and second-quarter results. No groundwater COPCs were identified based on first- or second-quarter sampling results. In addition, the results of Wilcoxon rank sum test background comparisons of inorganic CPSSs that exceeded their corresponding risk-based screening values did not identify any COPCs. Therefore, shallow groundwater was not assessed.

Table 6.2.12.1
Methods Run at AOC 662
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
662	B001	S	S	S	Y					S	Y					
662	B002	B	B	B	Y	Y	Y	Y	A	B	B					
662	B003	S	S	S	Y					S	Y					
662	B004	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.12.2
Methods Run at AOC 662
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
662	W001	S	S	S	Y					S	Y					
662	W002	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II:	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.12.3
Methods Run at AOC 662
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
662	W001	S	S	S												
662	W002	S	S	S												

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.12.4
AOC 662
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	2/ 4	28.00 - 30.00	27.000 - 33.000	30.000	780000.0000			
Aluminum	MG/KG	4/ 4		2130.000 - 3450.000	2692.500	7800.0000		25310.000	
Antimony	MG/KG	1/ 4	0.85 - 1.20	2.200 - 2.200	2.200	3.1000			
Arsenic	MG/KG	4/ 4		5.650 - 6.800	6.312	0.3700	4	14.810	
Barium	MG/KG	4/ 4		19.700 - 23.900	22.000	550.0000		40.330	
Benzo(a)pyrene Equivalents	UG/KG	4/ 4		32.213 - 64.426	40.266	88.0000			
Beryllium	MG/KG	4/ 4		0.580 - 0.740	0.652	0.1500	4	1.470	
Cadmium	MG/KG	4/ 4		0.200 - 0.330	0.250	3.9000		1.050	
Calcium	MG/KG	4/ 4		49800.000 - 56300.000	53700.000				
Chromium	MG/KG	4/ 4		18.500 - 20.800	19.350	39.0000		85.650	
Cobalt	MG/KG	4/ 4		2.000 - 12.900	5.462	470.0000		5.860	1
Copper	MG/KG	4/ 4		1.800 - 3.050	2.337	290.0000		27.600	
4,4'-DDE	UG/KG	2/ 4	4.00 - 4.00	2.650 - 4.000	3.325	1900.0000			
4,4'-DDT	UG/KG	1/ 4	7.00 - 8.00	3.700 - 3.700	3.700	1900.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1		0.661 - 0.661	0.661	1000.0000			
Fluoranthene	UG/KG	1/ 4	380.00 - 420.00	63.100 - 63.100	63.100	310000.0000			
Iron	MG/KG	4/ 4		3060.000 - 4240.000	3565.000			30910.000	
Lead	MG/KG	4/ 4		3.900 - 4.300	4.025	400.0000j		118.000	
Magnesium	MG/KG	4/ 4		533.000 - 729.000	605.750			9592.000	
Manganese	MG/KG	4/ 4		38.800 - 58.600	47.825	39.0000	3	636.400	
Mercury	MG/KG	1/ 4	0.02 - 0.03	0.020 - 0.020	0.020	2.3000		0.490	
Nickel	MG/KG	4/ 4		6.500 - 8.000	7.287	160.0000		33.380	
Potassium	MG/KG	4/ 4		243.000 - 343.000	291.500				
Pyrene	UG/KG	1/ 4	380.00 - 420.00	85.400 - 85.400	85.400	230000.0000			
Selenium	MG/KG	3/ 4	0.45 - 0.45	0.310 - 0.960	0.603	39.0000		2.000	
Sodium	MG/KG	4/ 4		961.000 - 1070.000	1040.250				
Vanadium	MG/KG	4/ 4		14.300 - 17.100	15.400	55.0000		77.380	
Zinc	MG/KG	4/ 4		13.700 - 15.300	14.500	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water

Table 6.2.12.5
AOC 662
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Barium	UG/L	2/ 2		7.100 - 29.600	18.350	260.0000		323.000	
Calcium	UG/L	2/ 2		137000.000 - 160000.000	148500.000				
Iron	UG/L	2/ 2		798.000 - 2770.000	1784.000				
Lead	UG/L	1/ 2	0.90 - 0.90	1.100 - 1.100	1.100	15.0000j		4.700	
Magnesium	UG/L	2/ 2		45600.000 - 66600.000	56100.000				
Manganese	UG/L	2/ 2		402.000 - 434.000	418.000	18.0000	2	3391.000	
Potassium	UG/L	2/ 2		21800.000 - 30700.000	26250.000				
Sodium	UG/L	2/ 2		301000.000 - 374000.000	337500.000				

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water

Table 6.2.12.6
AOC 662
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Barium	UG/L	2/ 2		10.700 - 24.700	17.700	260.0000		323.000	
Calcium	UG/L	2/ 2		110000.000 - 123000.000	116500.000				
Iron	UG/L	2/ 2		1560.000 - 1980.000	1770.000				
Magnesium	UG/L	2/ 2		36100.000 - 94000.000	65050.000				
Manganese	UG/L	2/ 2		379.000 - 629.000	504.000	18.0000	2	3391.000	
Methylene chloride	UG/L	2/ 2		1.500 - 1.800	1.650	4.1000			
Potassium	UG/L	2/ 2		17300.000 - 41100.000	29200.000				
Sodium	UG/L	2/ 2		237000.000 - 686000.000	461500.000				
Vanadium	UG/L	1/ 2	2.50 - 2.50	3.200 - 3.200	3.200	26.0000			

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

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6.2.13 Baseline Risk Assessment for AOC 663 and SWMU 136

6.2.13.1 Site Background and Investigative Approach

AOC 663 (which includes SWMU 136) was investigated to assess soil and groundwater at the Fuel Pumping Station, an active gasoline and diesel pumping station since 1983. Two 500-gallon USTs, five storage lockers for flammable materials, and an SAA just south of the pumping station were investigated. The SAA receives hazardous waste from Building NS-53 and Facility 851. These sources were described in the RFA (E/A&H, 1995b).

Samples were collected from surface soil (0 to 1 foot deep) at 10 locations. Table 6.2.13.1 lists the sample locations and the analytical methods used for the corresponding samples. Three shallow groundwater monitoring wells were installed and sampled. Tables 6.2.13.2 and 6.2.13.3 present the sample locations and analytical methods used for the first and second quarter.

6.2.13.2 COPC Identification

Soil

The risk-based screening values for manganese and cadmium, shown in Table 6.2.13.4, were calculated by USEPA using reference doses based on the ingestion of water. A reference dose based on the ingestion of food is also available for both of these elements, and would be more appropriately applied when calculating screening values for the incidental soil ingestion exposure pathway. Manganese and cadmium in soil were assessed further in this HHRA although neither would be expected to be a COPC based on a comparison to RBCs developed using oral RfDs applicable to food.

Based on the screening comparisons shown in Tables 6.2.13.4 and discussed in Section 6.1.3.4 of this report, the following COPCs were identified for the soil exposure pathways: 4,4'-DDE, aluminum, Aroclor-1254, arsenic, BEQs, cadmium, manganese, and vanadium. Wilcoxon rank sum test results indicated no significant difference between group sample concentrations for aluminum, cadmium, manganese, and vanadium onsite. The same results indicated background concentrations in shallow soil. For arsenic, however, test results showed site concentrations in shallow soil to be significantly higher than background with greater than 97% confidence. TPH was identified in four of five samples analyzed at concentrations ranging from 73 to 190 mg/kg. The maximum concentration exceeds the NAVBASE soil AL of 100 mg/kg.

Groundwater

TEQs were identified as groundwater COPCs based on first-quarter sampling results (see Table 6.2.13.5). Second-quarter results, presented in Table 6.2.13.6, indicate benzene is a COPC. Wilcoxon rank sum test results indicated that there was no significant difference between group sample concentrations at combined AOC 663 and background levels in shallow groundwater for any inorganic constituent. Therefore, TEQs and benzene were the only COPCs identified for formal groundwater risk and hazard assessment.

6.2.13.3 Exposure Assessment

Exposure Setting

The exposure setting at SWMU 136 and AOC 663, is a fuel pumping station and an SAA. The fuel pumping station (AOC 663) has been dispensing gasoline and diesel fuel since 1983. The SAA (SWMU 136) contains hazardous materials from adjacent buildings. This facility stores waste VOCs, metals, and petroleum products. Stained and cracked asphalt was noted near the pumping areas. Approximately 60% of the area is paved.

The future use of the site is not definite; however, it is expected to remain commercial/industrial. Combined AOC 663 is in an area proposed to become a marine cargo terminal in current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations include current and future site workers as well as hypothetical future site residents. Because many traditional activities at NAVBASE have ceased or are expected to cease in the near future, current site workers were not specifically addressed in the formal assessment. Due to the lack of knowledge regarding the specific functions that will be performed by future site workers, a standard default scenario was developed. A similar approach was applied for future site residents.

Exposure Pathways

Exposure pathways for future site workers and site residents were based on an evaluation of the impacted media identified at AOC 663 and SWMU 136. Relative to the soil matrix, incidental ingestion and dermal contact were considered viable exposure pathways. Ingestion and inhalation of COPCs identified in shallow groundwater were assessed in this HHRA. Uniform exposure was assumed for all sample locations. Table 6.2.13.7 presents the exposure pathway selection process and justifies each pathway evaluated.

Exposure Point Concentrations

At AOC 663 and SWMU 136, no more than 10 samples were collected from each potential exposure medium. As a result, the maximum concentration of each COPC identified in soil and groundwater was used as the EPC. The use of maximum concentrations does not account for variability in the groundwater and soil conditions.

Quantification of Exposure

Soil

Tables 6.2.13.8 and 6.2.13.9 present the CDIs for the ingestion and dermal soil contact pathways, respectively.

Groundwater

Tables 6.2.13.10 and 6.2.13.11 present the CDIs for the ingestion and inhalation groundwater pathways, respectively.

6.2.13.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.5 of this report. Table 6.2.13.12 summarizes toxicological risk information for the COPCs identified at this combined site. A reference dose was not available for BAP (as BEQ). A brief toxicological profile for cPAHs follows.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the BAP's B2 classification is based on insufficient human data specifically linking it to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question; the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per (mg/kg-day). The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, dibenz(a,h)anthracene, benzo(b)fluoranthene, benzo(a)anthracene, and benzo(k)flouranthene are classified B2 based on no human data but sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. It also produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. It is also mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.*** USEPA determined RfD's for only two of these compounds: pyrene's RfD_o is 0.03 mg/kg-day, also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

Dioxins are chlorinated hydrocarbons that accumulate in fat tissue. Exposure to dioxins, known to be potent mutagens and teratogens, causes burning pain in the tongue, abdomen, and pharynx, along with chloracne, loss of body weight, degenerative changes to the liver and thymus, and psychiatric disturbances. Chloracne is the primary sign of human exposure (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified dioxins as group B2 carcinogens and determined the SF_o to be 150,000 $(mg/kg\text{-}day)^{-1}$ for 2,3,7,8-TCDD. Equivalent concentrations of other dioxin congeners were calculated based on their corresponding toxic equivalents, as recommended by USEPA.

Aluminum, one of the most abundant metals in the earth's crust (7% aluminum), is ubiquitous in air and water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can potentially interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions. These contractions are part of the neuro-muscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen et al., 1986; Dreisbach et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based SMCL for drinking water is 50 to 200 μg/L, as established by USEPA's Office of Water.

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on an NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations.

Exposure to arsenic-containing materials has caused cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingesting these materials is associated with increased skin cancer rates . Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. As listed in IRIS (search date 9/1/95), classification is based on sufficient evidence from human data. Increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.038 μg/L, and USEPA's Office of Water has established an MCL of 0.05 mg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has been shown to cause kidney damage (including kidney stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system (Klaassen et al., 1986). USEPA set an oral RfD of 0.001 (mg/kg-day) based on human studies (food) involving chronic exposure in which significantly increased protein was found in the urine, along with an oral RfD for water of 0.0005 mg/kg-day. For inhalation exposure, USEPA classified cadmium as a group B1, or probable human carcinogen, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. As listed in IRIS (search date 6/28/95), the classification is based on limited evidence from occupational epidemiologic studies consistent across investigations and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven studies on rats and mice wherein cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route. As listed in IRIS, the critical effect of this chemical in water is significant proteinuria. The uncertainty factor was 10 and the modifying factor was 1. The uncertainty factor was 10 and the modifying factor was 1.

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Manganese uptake from water is greater than manganese from food, and the elderly appear to be more sensitive than children. Because of the different uptake rates in water and food, USEPA set two oral RfDs — one for water (0.005 mg/kg-day) and one for food (0.14 mg/kg-day). Inhaling manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified according to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS (search date 6/29/95), the classification is based on existing studies that are inadequate to assess the manganese's carcinogenicity. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day (Klaassen et al., 1986; Dreisbach et al., 1987). As listed in IRIS, the critical effects of this chemical in water in the oral summary are to the CNS. The uncertainty factor was 1 and the modifying factor was 1. The critical effects of this chemical in food in the oral summary are CNS effects. The uncertainty factor was 1 and the modifying factor was 1. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. The uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

PCB Aroclors are chlorinated hydrocarbons (such as ***Aroclor-1248, 1254, and 1260)*** that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme levels, rashes and chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified PCB Aroclors as group B2 carcinogens, primarily based on animal data. As listed in IRIS (search date 6/29/95), the classification is based on hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate yet suggestive evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. USEPA set 7.7 $(mg/kg\text{-}day)^{-1}$ as the SF_o for PCB Aroclors. Oral RfDs have been set for Aroclor-1016 (0.00007 mg/kg-day) and Aroclor-1254 (0.00002 mg/kg-day).

Benzene, a VOC which has been associated with leukemia, has been used as a solvent in coal tar naphtha, rubber, and plastic cement (Dreisbach et al., 1987). USEPA lists benzene as a group A carcinogen. As listed in IRIS (search date 6/29/95), the classification is based on several studies of increased incidence of nonlymphocytic leukemia from occupational exposure, increased incidence of neoplasia in rats and mice exposed by inhalation and gavage, and some supporting data. In large doses, benzene depresses the CNS and chronic exposure depresses bone marrow. The oral SF for benzene was set by USEPA as 2.9E-2 $(mg/kg\text{-}day)^{-1}$; a provisional oral RfD has been set at 3E-4 mg/kg-day. Occupational inhalation exposure to benzene is acceptable by OSHA at concentrations of 3.25 mg/m^3 or 1 ppm in air (NIOSH, 1990).

Vanadium is not readily absorbed through the skin or oral ingestion and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaassen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear and the primary focus of toxicological information is inhalation of vanadium dust. Typical vitamin supplements contain approximately 0.010 mg in a daily dose. The RfD_o set by USEPA is 0.007 mg/kg-day.

4,4'-DDE is a compound typical of halobenzene derivatives and is a by-product of the pesticide DDT. It is soluble in fat, but not in water, and its primary target organs are the liver and brain (Dreisbach et al., 1987). DDE is the form of DDT which accumulates in organisms and is thought to be responsible for egg shell thinning and other ecological effects. DDE bioconcentrates in aquatic organisms and can significantly alter the ecology of some areas, especially where DDE-containing aquatic species are a critical species in the food chain (Harte et al., 1991). This compound is listed as a B2 carcinogen, and USEPA set the SF_o for DDE to 0.34 $(mg/kg\text{-}day)^{-1}$.

6.2.13.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 6.2.13.13 and 6.2.13.14 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soil, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 663 and SWMU 136 surface soil is 1E-4. The dermal pathway ILCR is 3E-5. BAP and arsenic are the primary contributors to ILCR for each pathway. Aroclor-1254 and 4,4'-DDE also contribute to the overall cancer risk projections.

The HIs for the adult and child ingestion pathway were estimated to be 0.2 and 2, respectively. The dermal HIs for the adult and child were estimated to be 0.08 and 0.3, respectively. Primary contributors to the HI are arsenic, Aroclor-1254, and aluminum for both the ingestion and dermal exposure pathways.

Hypothetical Site Workers

Site worker ILCRs are 1E-5 for both the ingestion and dermal contact pathways. The ingestion and dermal contact HIs for the site worker scenario were estimated to be 0.08 and 0.06, respectively. Primary contributors to the HI are arsenic, Aroclor-1254, and aluminum for both the ingestion and dermal exposure pathways.

Although the frequency of detection is low for some COPCs, a formal hot spot approach was not used to estimate exposure. Arsenic was reported in nine of all surface soil samples analyzed, and would not be affected by a percent area adjustment. The Wilcoxon rank sum results indicate that soil arsenic concentrations are significantly greater than background, and therefore, arsenic was included as a COPC. BEQs were reported in approximately 50% of the site. Reducing the exposure estimate for BEQs by 50% would not significantly reduce the risk estimates for the combined sites. Variability in the BEQ exposure estimates exists because the three hits are spread across the site and do not clearly define an area.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under both residential and industrial (site worker) scenarios. The ingestion and inhalation pathways were evaluated for each. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 6.2.13.15 and 6.2.13.16 present the computed carcinogenic risks and/or HQs associated with the groundwater ingestion and inhalation pathways, respectively. Benzene was the sole COPC identified in shallow groundwater, and was detected exclusively in second-quarter samples.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for groundwater is 7E-5. The inhalation pathway ILCR is 7E-5. Benzene was the primary contributor to ILCR, and 2,3,7,8-TCDD accounted for the rest. The HIs for the adult and child ingestion pathway were estimated to be 15 and 34, respectively. The inhalation HIs for the adult and child receptors were estimated to be 3 and 6, respectively. Benzene was the only contributor to the HI.

Hypothetical Site Workers

Site worker ILCRs are 2E-5 for both the ingestion and inhalation pathways. The ingestion and inhalation HIs for the site worker scenario were estimated to be 5 and 1, respectively. Benzene was the primary contributor to ILCR, and 2,3,7,8-TCDD accounted for the rest. Benzene was the only contributor to the hazard index.

2,3,7,8-TCDD was reported in only one well during the first quarter of shallow groundwater monitoring, and benzene was reported in the same well in the second-quarter groundwater sample. The concentration reported for 2,3,7,8-TCDD is approximately one order of magnitude less than the MCL of 3E-8 mg/L.

COCs Identified

COCs were based on cumulative (all pathway) risk and hazard projected for this site, as shown in Table 6.2.13.15. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or an HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is comparatively conservative because USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection algorithm was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

The soil exposure scenarios were maintained in both instances. Under the traditional risk-based COC trigger provisions, no carcinogenic COCs would be identified under the hypothetical residential use scenario for soil or groundwater because the cumulative risk is well below 1E-4.

Surface Soil

Hypothetical Site Residents *(Future Land Use)*

Aroclor-1254, BEQs, 4,4'-DDE, aluminum, arsenic, and vanadium were identified as COCs for this scenario based on their contribution to risk/hazard. Primary contributors to the HI are arsenic, PCB Aroclor-1254 and aluminum for both the ingestion and dermal exposure pathways. Arsenic is the largest contributor to ILCR for the ingestion pathway, while BAP contributes most to the dermal contact ILCR.

Hypothetical Site Workers *(Current Land Use)*

Aroclor-1254, BEQs, and arsenic were identified as COCs for this scenario based on their contribution to risk. BAP and arsenic are the primary contributors to ILCR.

Groundwater

Hypothetical Site Residents *(Future Land Use)*

Benzene and TEQs were identified as COCs for this scenario based on their contribution to risk/hazard. Benzene was the sole contributor to ILCR.

Hypothetical Site Workers *(Future Land Use)*

Benzene was the only COC identified for this scenario based on its contribution to risk/hazard.

Due to the limited extent of identified shallow groundwater impacts, graphical presentation of risk projections for AOC 663 groundwater was determined to be of limited use. Instead, the extent of the COC is briefly discussed below. Benzene appeared in one second-quarter sample. TEQs were detected in the one first-quarter shallow groundwater sample analyzed for dioxins.

Due to the hydrophobic nature of dioxins, they are not expected to migrate from soil to groundwater. It has been suspected that first-quarter results may reflect the influence of sediment entrained in the monitored zone during well installation. Consideration of third- and fourth-quarter results will confirm whether TEQs are present in shallow groundwater. This review will facilitate responsible and sound risk management decisions.

6.2.13.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site groundwater, and approximately 60% of the site is paved. Site workers are infrequently exposed to surface soil when walking across the site, pumping fuel, or during activities. Site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. Pumping fuel onsite 52 days per year would result in one-fifth the projected risk/hazard for site workers. If the exposure were adjusted to account for the percentage of time spent pumping fuel, CDI (and thus risk/hazard estimates) would be much less than that presented in Section 6.2.13.3.

Residential use of the site would not be expected, based on current uses and the nature of surrounding buildings. Current reuse plans call for continued commercial and/or industrial use of Zone H as a marine cargo terminal. If this area was used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at AOC 663 and SWMU 136 for potable or industrial purposes. The basewide system that supplies drinking and process water to buildings throughout Zone H is to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed.

Determination of Exposure Point Concentrations

The maximum reported concentrations of soil and groundwater COPCs were used as the respective EPCs for this site.

Frequency of Detection and Spatial Distribution

Of the COCs identified in this HHRA for surface soil, PCB Aroclor-1254 and BEQs were detected in 50% or less of the samples analyzed. PCB Aroclor-1254 was detected in only one of nine samples analyzed. The use of the maximum reported concentration as EPC for PCB Aroclor-1254, BEQs, 4,4'-DDE, aluminum, arsenic, and vanadium overestimates exposure. If concentrations other than the maximum reported were adjusted by the FI multiplier from contaminated source and the resulting EPCs were applied to the risk calculations at AOC 663, the risk estimates for surface soil and groundwater would be estimated at less than 1E-4, which is within the USEPA acceptable risk range. The same concept would apply to the HI, which would be estimated to be below the USEPA HI threshold of 1.

Based on second-quarter groundwater data, benzene and 2,3,7,8-TCDD were identified as COCs; each compound was detected in only one sample. Combined AOC 663 and SWMU 136 were a pumping station and could be a source of benzene. Third and fourth quarters of groundwater monitoring data should be used to confirm whether these COCs are present. Risk management decisions based on risk/hazard estimates for these compounds should be made after third- and fourth-quarter groundwater monitoring results are obtained.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

As a measure of variability, CT was analyzed for soil and groundwater. Exposure assumptions were modified to reflect the 50th percentile rather than the 95th, and exposure point concentrations were not modified. In accordance with *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure-Draft* (USEPA, 1993), the exposure duration of site residents were reduced from 30 to nine years, two years for child exposure, and seven years for adult exposure. Exposure frequency was reduced from 350 to 234 days for site residents and from 250 to 219 days for site workers. The drinking water ingestion rate for an adult was reduced from 2 to 1.4 liters per day, and exposure to groundwater was reduced by 25% to account for other water sources. Soil ingestion rates for site residents were reduced by 50%, and dermal surface area was not modified. CDI, risk and hazard based on CT exposure assumptions are presented and discussed below.

Soil

Four of the soil samples were collected by coring through asphalt, which could be a source of CPSSs. The remaining samples were collected next to pavement which covered a diesel UST. Runoff from the concrete pad onto site soil could be the source of some CPSSs in soil. The maximum concentration of BEQs was reported in this area in sample 663SB007.

Of the CPSSs eliminated from formal assessment because they did not exceed the corresponding RBCs, none other than chlordane was reported at a concentration within approximately 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Although the maximum of neither alpha-chlordane nor gamma-chlordane exceeds the corresponding risk-based screening value, the sum of the maximum reported concentrations for the chlordane isomers exceeds the corresponding risk-based screening value. However, the arithmetic mean of the two chlordane isomers does not approach the risk-based screening value, and a significant contribution to risk/hazard would not be expected based on the mean reported concentrations. Chlordane would not be expected as a COPC based on historical use as a fuel pumping station. Concentrations of beryllium and chromium exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding reference concentrations. Therefore, they were eliminated from formal assessment based on comparisons to the reference concentrations because they did not contribute to excess risk/hazard onsite.

Both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard. BEQs and arsenic, the primary contributors to soil risk, were not adjusted for the FI/FC. Arsenic was reported in all nine samples and was determined to be significantly above background concentrations (based on the Wilcoxon rank sum results for arsenic). The exposure estimates for these COPCs were based on the maximum reported concentrations; variability was not addressed. If arsenic is at some point determined not to be a concern onsite, the distribution of BAP in surface soil should be considered, and variability should also be addressed. The mean concentration of BEQs reported in combined AOC 663 surface soil (0.77 mg/kg) would result in ILCR of approximately 3E-6 for the cumulative soil resident (as opposed to 2E-5, which was based on the maximum reported concentration). A map was not produced for this site.

CDIs based on CT exposure assumptions are presented in Tables 6.2.13.18 and 6.2.13.19 for incidental ingestion of soil and dermal contact with soil, respectively. Risk and hazard based on CT are presented in Tables 6.2.13.20 and 6.2.13.21 for incidental ingestion of soil and dermal contact with soil, respectively.

Hypothetical Site Residents (Future Land Use)

ILCR estimated for the incidental ingestion pathway was 1E-5. Arsenic and BEQs were the primary contributors to ICLR. HIs estimated for this pathway were 0.1 and 1 for the adult and child scenarios, and arsenic, PCB Aroclor-1254, and aluminum accounted for most of the hazard estimated for the ingestion exposure pathway.

ILCR estimated for the dermal contact pathway was 7E-6. BEQs, arsenic, and PCB Aroclor-1254 were primary contributors to ICLR. Hazard indices estimated for this pathway were 0.05 and 0.2 for the adult and child scenarios, and arsenic, PCB Aroclor-1254, and aluminum accounted for most of the hazard estimated for the ingestion exposure pathway.

Hypothetical Site Workers ***(Current Land Use)***

ILCR estimated for the ingestion pathway was 2E-6 and the HI was estimated to be 0.07. Arsenic and BEQs were the primary contributors to ICLR. Arsenic, PCB Aroclor-1254, and aluminum accounted for most of the hazard estimated for the ingestion exposure pathway. The dermal contact pathway ILCR was estimated to be 2E-6, and the HI was estimated to be 0.05. BEQs, arsenic, and PCB Aroclor-1254 were primary contributors to ICLR. Arsenic, PCB Aroclor-1254, and aluminum accounted for most of the hazard estimated for the ingestion exposure pathway.

Groundwater

Of the CPSSs eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration close to its RBC, reducing the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of arsenic and manganese exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed corresponding reference concentrations.

CDIs calculated based on CT exposure to shallow groundwater are presented in Table 6.2.13.22. Risk and hazard based on CT are presented in Tables 6.2.13.23 and 6.2.13.24 for ingestion and inhalation of COPCs identified in shallow groundwater.

Hypothetical Site Residents *(Future Land Use)*

ILCR estimated for the ingestion of shallow groundwater was 9E-6. The only contributors to ILCR were benzene and BEQs, and benzene accounted for more than 95% of the ILCR. Benzene was assessed for inhalation exposure, and inhalation ILCR was estimated to be 9E-6. The HIs for the adult and child ingestion and inhalation exposure pathways were based on benzene only, and were estimated to be 5 and 17 for the ingestion pathway, respectively. HIs for the adult and child exposure inhalation pathways were estimated to be 0.9 and 3, respectively.

Hypothetical Site Workers *(Future Land Use)*

The ingestion exposure pathway ILCR was estimated to be 2E-6 for the site worker exposure scenario. Benzene accounted for greater than 95% of the ILCR estimate. The HI estimated for future site workers was 3, and benzene was the sole contributor to hazard for this pathway. Benzene was also assessed for the inhalation exposure pathway, and the site worker ILCR was estimated to be 2E-6. The inhalation HI estimate was 0.6.

6.2.13.7 Risk Summary

The risk and hazard posed by contaminants at combined AOC 663 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion and inhalation were evaluated for shallow groundwater based on first- and second-quarter groundwater monitoring data. Table 6.2.13.25 summarizes risk for each pathway/receptor group evaluated for combined AOC 663.

6.2.13.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident and adult site worker, as presented in Tables 6.2.13.26 and 6.2.13.27 for surface soil. Hazard-based RGOs were calculated based on either the hypothetical child resident or the adult site worker, as noted in each of the corresponding tables.

Groundwater

Groundwater RGOs based on site residents and site workers are shown in Tables 6.2.13.28 and 6.2.13.29, respectively.

136	B002	S	S	S	Y					S	Y					
136	B003	S	S							S						
136	B004	S	S							S						
663	B001	S	S	S	Y					S	Y					
663	B002	B	B	B	Y	Y	Y	Y	A	B	B					
663	B004	S	S	S	Y					S	Y					
663	B005	S	S	S	Y					S	Y					
663	B006	S	S							S						
663	B007	S	S							S						
663	B009		S													
663	B04A													Y	Y	Y
663	B05A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

[redacted]

136	W001	S	S	S	Y					S	Y
663	W001	B	B	B	Y	Y	Y	Y	A	B	B
663	W002	S	S	S	Y					S	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
		Tph:	Total Petroleum Hydrocarbons: Method 418.1
VOA:	Volatile Organics: Method 8240	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
SVOA:	Semi-volatile Organics: Method 8270		
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

[redacted]

136	W001	S	S	S					
663	W001	S	S	S					S
663	W002	S	S	S					S

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

[redacted]

Acenaphthylene	UG/KG	1/ 10	330.00 -	550.00	1600.000 -	1600.000	1600.000	470000.0000e			
* Aluminum	MG/KG	9/ 9			724.000 -	31900.000	7676.000	7800.0000	1	25310.000	1
Anthracene	UG/KG	3/ 10	400.00 -	550.00	43.900 -	2200.000	774.866	2300000.0000			
* Aroclor-1254	UG/KG	1/ 9	33.00 -	78.00	695.000 -	695.000	695.000	83.0000	1		
* Arsenic	MG/KG	9/ 9			3.300 -	23.900	9.444	0.3700	9	14.810	2
delta-BHC	UG/KG	1/ 9	1.70 -	5.00	4.000 -	4.000	4.000	490.0000l			
Barium	MG/KG	5/ 9	7.30 -	38.00	9.500 -	29.900	19.160	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	4/ 10	400.00 -	550.00	139.500 -	780.000	523.625	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	10/ 10			85.293 -	4422.560	692.566	88.0000	5		
Benzo(a)anthracene	UG/KG	5/ 10	400.00 -	550.00	69.800 -	1400.000	468.120				
Benzo(b)fluoranthene	UG/KG	5/ 10	400.00 -	550.00	168.000 -	6300.000	1720.200				
Chrysene	UG/KG	5/ 10	400.00 -	550.00	82.100 -	3500.000	954.120				
Dibenzo(a,h)anthracene	UG/KG	3/ 10	400.00 -	550.00	49.300 -	350.000	237.433				
Indeno(1,2,3-cd)pyrene	UG/KG	4/ 10	400.00 -	550.00	124.050 -	980.000	531.762				
Benzo(k)fluoranthene	UG/KG	1/ 10	400.00 -	550.00	212.000 -	212.000	212.000				
Benzo(a)pyrene	UG/KG	5/ 10	400.00 -	550.00	82.900 -	3200.000	882.680				
Beryllium	MG/KG	9/ 9			0.105 -	1.400	0.421	0.1500	8	1.470	
* Cadmium	MG/KG	7/ 9	0.14 -	1.50	0.180 -	7.400	1.438	3.9000	1	1.050	1
Calcium	MG/KG	9/ 9			3200.000 -	411000.000	84276.666				
alpha-Chlordane	UG/KG	5/ 9	3.60 -	103.00	3.000 -	389.000	88.000	470.0000			
gamma-Chlordane	UG/KG	5/ 9	3.60 -	154.00	6.000 -	423.000	98.120	470.0000			
Chromium	MG/KG	9/ 9			8.100 -	54.300	24.872	39.0000	2	85.650	
Cobalt	MG/KG	9/ 9			1.100 -	8.300	3.066	470.0000		5.860	1
Copper	MG/KG	5/ 9	5.80 -	10.40	1.500 -	67.250	28.250	290.0000		27.600	2
4,4'-DDD	UG/KG	5/ 9	7.20 -	10.00	14.900 -	1940.000	419.660	2700.0000			
* 4,4'-DDE	UG/KG	8/ 9	4.00 -	4.00	3.000 -	4480.000	631.037	1900.0000	1		
4,4'-DDT	UG/KG	6/ 9	8.00 -	10.00	12.800 -	1390.000	267.083	1900.0000			
Di-n-butylphthalate	UG/KG	1/ 10	330.00 -	550.00	40.900 -	40.900	40.900	780000.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1			4.929 -	4.929	4.929	1000.0000			
Endosulfan I	UG/KG	1/ 9	1.70 -	5.00	10.000 -	10.000	10.000	47000.0000			
Endrin	UG/KG	1/ 9	3.30 -	5.00	7.950 -	7.950	7.950	2300.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	4/ 10	400.00 -	550.00	61.900 -	904.000	290.675	46000.0000			
Fluoranthene	UG/KG	8/ 10	400.00 -	550.00	48.800 -	1970.000	609.412	310000.0000			
Fluorene	UG/KG	1/ 10	330.00 -	550.00	160.000 -	160.000	160.000	310000.0000			

[redacted]

	Heptachlor epoxide	UG/KG	3/ 9	3.60 -	5.00	3.000 -	31.100	13.563	70.0000			
	Iron	MG/KG	9/ 9			4030.000 -	37700.000	11093.333			30910.000	I
	Lead	MG/KG	7/ 9	1.30 -	16.00	22.600 -	118.000	54.321	400.0000j		118.000	1
	Magnesium	MG/KG	9/ 9			358.000 -	3710.000	1701.666			9592.000	
*	Manganese	MG/KG	9/ 9			28.200 -	826.000	170.933	39.0000	7	636.400	I
	Mercury	MG/KG	4/ 9	0.03 -	0.03	0.030 -	0.190	0.122	2.3000		0.490	
	Methylene chloride	UG/KG	1/ 5	12.00 -	13.00	11.200 -	11.200	11.200	85000.0000			
	Nickel	MG/KG	6/ 9	5.40 -	7.80	6.400 -	17.100	10.633	160.0000		33.380	
	Phenanthrene	UG/KG	4/ 10	400.00 -	550.00	41.300 -	608.000	228.325	310000.0000k			
	Potassium	MG/KG	3/ 9	261.00 -	579.00	309.000 -	2100.000	1136.333				
	Pyrene	UG/KG	6/ 10	400.00 -	550.00	90.000 -	3400.000	953.983	230000.0000			
	Selenium	MG/KG	2/ 9	0.29 -	0.68	0.340 -	0.510	0.425	39.0000		2.000	
	Sodium	MG/KG	9/ 9			60.700 -	214.000	142.444				
	2,4,5-TP (Silvex)	UG/KG	1/ 1			7.300 -	7.300	7.300	63000.0000			
*	Petroleum Hydrocarbons, TPH	MG/KG	4/ 5	71.00 -	71.00	73.000 -	190.000	145.750	10.0000	4		
	Tin	MG/KG	1/ 1			2.000 -	2.000	2.000	4700.0000			
*	Vanadium	MG/KG	9/ 9			4.400 -	84.500	25.666	55.0000	1	77.380	I
	Zinc	MG/KG	7/ 9	15.70 -	27.90	48.400 -	816.000	218.128	2300.0000		214.300	I

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- e Acenaphthene used as surrogate
- f Fluoranthene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate
- l gamma-BHC (Lindane) used as surrogate

[redacted]

Aluminum	UG/L	1/ 3	15.10 -	15.10	984.000 -	984.000	984.000	3700.0000		
Arsenic	UG/L	1/ 3	7.80 -	16.50	7.100 -	7.100	7.100	0.0380	1	27.990
Barium	UG/L	2/ 3	0.80 -	0.80	4.300 -	21.500	12.900	260.0000		323.000
Calcium	UG/L	3/ 3			51700.000 -	131000.000	87466.666			
2,4-DB	UG/L	1/ 1			1.600 -	1.600	1.600	29.0000		
* Dioxin (TCDD TEQ)	PG/L	1/ 1			1.328 -	1.328	1.328	0.5000	1	
1234678-HpCDD	PG/L	1/ 1			5.585 -	5.585	5.585			
1234789-HpCDF	PG/L	1/ 1			0.548 -	0.548	0.548			
123678-HxCDD	PG/L	1/ 1			1.397 -	1.397	1.397			
234678-HxCDF	PG/L	1/ 1			0.769 -	0.769	0.769			
OCDD	PG/L	1/ 1			17.674 -	17.674	17.674			
OCDF	PG/L	1/ 1			2.908 -	2.908	2.908			
12378-PeCDD	PG/L	1/ 1			1.918 -	1.918	1.918			
2378-TCDF	PG/L	1/ 1			0.712 -	0.712	0.712			
Iron	UG/L	3/ 3			1530.000 -	8500.000	4133.333			
Magnesium	UG/L	3/ 3			9270.000 -	63100.000	30056.666			
Manganese	UG/L	3/ 3			29.200 -	548.000	242.066	18.0000	3	3391.000
Potassium	UG/L	3/ 3			11600.000 -	41400.000	22000.000			
Sodium	UG/L	3/ 3			83100.000 -	577000.000	268033.333			

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

[redacted]

	Aluminum	UG/L	2/ 3	15.40 -	15.40	17.900 -	1700.000	858.950	3700.0000		
	Arsenic	UG/L	1/ 3	3.20 -	4.40	12.200 -	12.200	12.200	0.0380	1	27.990
	Barium	UG/L	3/ 3			2.500 -	19.300	9.133	260.0000		323.000
*	Benzene	UG/L	1/ 3	5.00 -	5.00	160.000 -	160.000	160.000	0.3460	1	
	Calcium	UG/L	3/ 3			42800.000 -	109000.000	77333.333			
	Ethylbenzene	UG/L	1/ 3	5.00 -	5.00	19.000 -	19.000	19.000	130.0000		
	Iron	UG/L	3/ 3			2970.000 -	7130.000	4420.000			
	Magnesium	UG/L	3/ 3			11400.000 -	61550.000	32150.000			
	Manganese	UG/L	3/ 3			41.500 -	539.000	249.166	18.0000	3	3391.000
	Phenol	UG/L	1/ 3	11.00 -	11.00	7.200 -	7.200	7.200	2200.0000		
	Potassium	UG/L	3/ 3			11700.000 -	37750.000	21516.666			
	Sodium	UG/L	3/ 3			131000.000 -	370000.000	219000.000			
	Toluene	UG/L	1/ 3	5.00 -	5.00	37.000 -	37.000	37.000	75.0000		
	Vanadium	UG/L	1/ 3	2.50 -	2.50	7.000 -	7.000	7.000	26.0000		
	Xylene (total)	UG/L	1/ 3	5.00 -	5.00	26.000 -	26.000	26.000	1200.0000		
	Zinc	UG/L	1/ 3	5.80 -	5.80	10.600 -	10.600	10.600	1100.0000		

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.13.7
Exposure Pathways Summary — AOC 663
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 663.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 663.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	CPSSs were greater than RBC and Reference concentrations.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.

Table 6.2.13.7
Exposure Pathways Summary — AOC 663
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.13.8
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	0.695	9.52E-07	8.89E-06	1.09E-06	3.40E-07	1.21E-07
Benzo(a)pyrene equivalents	4.42	6.05E-06	5.65E-05	6.92E-06	2.16E-06	7.72E-07
4,4'-DDE	4.48	6.14E-06	5.73E-05	7.01E-06	2.19E-06	7.83E-07
Aluminum	31900	4.37E-02	4.08E-01	4.99E-02	1.56E-02	5.57E-03
Arsenic	23.9	3.27E-05	3.06E-04	3.74E-05	1.17E-05	4.18E-06
Cadmium	7.4	1.01E-05	9.46E-05	1.16E-05	3.62E-06	1.29E-06
Manganese	826	1.13E-03	1.06E-02	1.29E-03	4.04E-04	1.44E-04
Vanadium	84.5	1.16E-04	1.08E-03	1.32E-04	4.13E-05	1.48E-05

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 6.2.13.9
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	0.695	0.01	3.90E-07	1.29E-06	2.44E-07	2.79E-07	9.96E-08
Benzo(a)pyrene equivalents	4.42	0.01	2.48E-06	8.19E-06	1.55E-06	1.77E-06	6.33E-07
4,4'-DDE	4.48	0.01	2.52E-06	8.31E-06	1.57E-06	1.80E-06	6.42E-07
Aluminum	31900	0.001	1.79E-03	5.91E-03	1.12E-03	1.28E-03	4.57E-04
Arsenic	23.9	0.001	1.34E-06	4.43E-06	8.40E-07	9.59E-07	3.42E-07
Cadmium	7.4	0.001	4.16E-07	1.37E-06	2.60E-07	2.97E-07	1.06E-07
Manganese	826	0.001	4.64E-05	1.53E-04	2.90E-05	3.31E-05	1.18E-05
Vanadium	84.5	0.001	4.75E-06	1.57E-05	2.97E-06	3.39E-06	1.21E-06

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.13.10
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Vinyl chloride	0.0021	5.75E-05	1.34E-04	3.16E-05	2.14E-05	7.63E-06
Chloromethane	0.006	1.64E-04	3.84E-04	9.04E-05	6.11E-05	2.18E-05

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.13.10
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Benzene	0.16	4.38E-03	1.02E-02	2.41E-03	1.63E-03	5.81E-04
2,3,7,8-TCDD Equivalents	1.33E-09	3.64E-11	8.50E-11	2.00E-11	1.35E-11	4.83E-12

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

ıble 6.2.13.11
ızard Quotients and Incremental Lifetime Cancer Risks
halation of Contaminants Volatilized from Shallow Groundwater
ϽC 663/SWMU 136
ıval Base Charleston
ıarleston, SC

hemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
enzene	0.00171	0.029	2.6	6.0	7.0E-05	0.9	1.6E-05
UM Hazard Index/ILCR			3	6	7E-05	0.9	2E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

ble 6.2.13.12 - AOC 663
xicological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

emical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation
uminum	1	e			ND	ND				ND
senic	0.0003	a	M	hyperpigmentation	3	ND				ND
admium (food)	0.001	a	H	proteinuria	10	ND				ND
admium (water)	0.0005	a	H	proteinuria	10	ND				ND
anganese (water)	0.005	a	NA	neurological effects	1	1.43E-05	a	M	neurological effects	1000
anganese (food)	0.14	a	NA	neurological effects	1	ND				ND
CB Aroclor-1254	2E-05	a	NA		ND	ND				ND
nzo(a)pyrene Equivalents	ND				ND	ND				ND
I'-DDE	ND				ND	ND				ND
nadium	0.007	a		unclear	100	ND				ND
nzene	ND				ND	0.00171	e	NA		ND
,7,8-TCDD	ND				ND	ND				ND

NOTES:

a Integrated Risk Information System (IRIS)
b Health Effects Assessment Summary Tables (HEAST)
e EPA Environmental Criteria and Assessment Office - Cincinnati (provisional)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

ble 6.2.13.12 - AOC 663
xicological Database Information
Chemicals of Potential Concern
.VBASE Charleston, Zone H

Carcinogenic Toxicity Data

emical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
ıminum	ND		ND		ND	
;enic	1.5	a	15.1	a	A	various
dmium (food)	ND		6.3	a	B1	lung
dmium (water)	ND		6.3	a	B1	lung
ınganese (water)	ND		ND		D	
ınganese (food)	ND		ND		D	
:B Aroclor-1254	7.7		ND		B2	hepatocellular carcinoma
nzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
I'-DDE	0.34	a	ND		B2	liver
nadium	ND		ND		D	
nzene	0.029	a	0.029	a	A	leukemia
,7,8-TCDD	150000	b			B2	mutagen and teratogen

Table 6.2.13.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	2E-05	7.7	0.048	0.44	8.4E-06	0.017	9.4E-07
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	5.1E-05	ND	5.6E-06
4,4'-DDE	NA	0.34	ND	ND	2.4E-06	ND	2.7E-07
Aluminum	1	NA	0.044	0.41	ND	0.016	ND
Arsenic	0.0003	1.5	0.109	1.02	5.6E-05	0.039	6.3E-06
Cadmium	0.001	NA	0.010	0.09	ND	0.004	ND
Manganese	0.14	NA	0.008	0.08	ND	0.003	ND
Vanadium	0.007	NA	0.017	0.15	ND	0.006	ND
SUM Hazard Index/ILCR			0.2	2	1E-04	0.08	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.13.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	0.5	1E-05	15.4	0.0390	0.129	3.8E-06	0.028	1.5E-06
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	2.3E-05	ND	9.2E-06
4,4'-DDE	0.5	NA	0.68	ND	ND	1.1E-06	ND	4.4E-07
Aluminum	0.2	0.2	NA	0.0090	0.030	ND	0.006	ND
Arsenic	0.2	6E-05	7.5	0.0224	0.074	6.3E-06	0.016	2.6E-06
Cadmium	0.2	0.0002	NA	0.0021	0.007	ND	0.001	ND
Manganese	0.2	0.028	NA	0.0017	0.005	ND	0.001	ND
Vanadium	0.2	0.0014	NA	0.0034	0.011	ND	0.002	ND
SUM Hazard Index/ILCR				0.077	0.3	3E-05	0.06	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.13.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzene	0.0003	0.029	14.6	34.1	7.0E-05	5.4	1.7E-05
2,3,7,8-TCDD Equivalents	NA	150000	ND	ND	3.0E-06	ND	7.3E-07
SUM Hazard Index/ILCR			15	34	7E-05	5	2E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.13.16
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzene	0.00171	0.029	2.6	6.0	7.0E-05	1.0	1.7E-05
SUM Hazard Index/ILCR			3	6	7E-05	1	2E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

able 6.2.13.17 Summary of Carcinogenic Risk and Non-carcinogenic Hazard
nd Identification of Chemicals of Concern
OC 663/SWMU 136
aval Base Charleston
harleston, SC

edium/Pathway	Chemical	Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident Iwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs
oil Incidental Ingestion	Aroclor-1254	0.048	0.44	8.4E-06	0.017	9.4E-07	1 2
	Benzo(a)pyrene equivalents	ND	ND	5.1E-05	ND	5.6E-06	2 4
	4,4'-DDE	ND	ND	2.4E-06	ND	2.7E-07	2
	Aluminum	0.044	0.41	ND	0.016	ND	1
	Arsenic	0.109	1.02	5.6E-05	0.039	6.3E-06	1 2 4
	Cadmium	0.010	0.09	ND	0.004	ND	
	Manganese	0.008	0.08	ND	0.003	ND	
	Vanadium	0.017	0.15	ND	0.006	ND	1
oil Incidental Ingestion Pathway Total		0.2	2	1E-04	0.08	1E-05	
oil Dermal Contact Pathway	Aroclor-1254	0.0390	0.129	3.8E-06	0.028	1.5E-06	2 4
	Benzo(a)pyrene equivalents	ND	ND	2.3E-05	ND	9.2E-06	2 4
	4,4'-DDE	ND	ND	1.1E-06	ND	4.4E-07	2
	Aluminum	0.0090	0.030	ND	0.006	ND	
	Arsenic	0.0224	0.074	6.3E-06	0.016	2.6E-06	2 4
	Cadmium	0.0021	0.007	ND	0.001	ND	
	Manganese	0.0017	0.005	ND	0.001	ND	
	Vanadium	0.0034	0.011	ND	0.002	ND	
oil Dermal Contact Pathway Total		0.08	0.3	3E-05	0.055	1E-05	
allow/Intermediate Groundwater Ingestion Pathway	Benzene	14.6	34.1	7.0E-05	5.4	1.7E-05	1 2 3 4
	2,3,7,8-TCDD Equivalents	ND	ND	3.0E-06	ND	7.3E-07	2
allow/Intermediate Groundwater Ingestion Pathway Total		15	34	7E-05	5	2E-05	
allow/Intermediate Groundwater Inhalation Pathway	Benzene	2.6	6.0	7.0E-05	1.0	1.7E-05	1 2 4
allow Groundwater Inhalation Pathway Total		3	6	7E-05	1	2E-05	
Pathways Cumulative Total Risk/Hazard		17	43	3E-04	7	6E-05	

TES are continued on the following page.

ıle 6.2.13.17 (continued)

TES:

indicates not applicable
A indicates lifetime weighted average
Chemical is a COC by virtue of projected child resident non-carcinogenic hazard.
Chemical is a COC by virtue of projected future resident lifetime weighted average carcinogenic risk.
Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
Chemical is a COC by virtue of projected site worker carcinogenic risk.
e concentration reported for dioxin in groundwater is approximately an order of magnitude less than the corresponding MCL.

Table 6.2.13.18
Central Tendency Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	0.695	3.18E-07	2.97E-06	1.17E-07	2.98E-07	1.60E-08
Benzo(a)pyrene equivalents	4.42	2.02E-06	1.89E-05	7.42E-07	1.89E-06	1.01E-07
4,4'-DDE	4.48	2.05E-06	1.91E-05	7.52E-07	1.92E-06	1.03E-07
Aluminum	31900	1.46E-02	1.36E-01	5.36E-03	1.37E-02	7.32E-04
Arsenic	23.9	1.09E-05	1.02E-04	4.01E-06	1.02E-05	5.49E-07
Cadmium	7.4	3.39E-06	3.16E-05	1.24E-06	3.17E-06	1.70E-07
Manganese	826	3.78E-04	3.53E-03	1.39E-04	3.54E-04	1.90E-05
Vanadium	84.5	3.87E-05	3.61E-04	1.42E-05	3.62E-05	1.94E-06

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 6.2.13.19
Central Tendency Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	0.695	0.01	2.61E-07	8.61E-07	5.07E-08	2.44E-07	1.74E-08
Benzo(a)pyrene equivalents	4.42	0.01	1.66E-06	5.48E-06	3.22E-07	1.55E-06	1.11E-07
4,4'-DDE	4.48	0.01	1.68E-06	5.55E-06	3.27E-07	1.57E-06	1.12E-07
Aluminum	31900	0.001	1.20E-03	3.95E-03	2.33E-04	1.12E-03	8.01E-05
Arsenic	23.9	0.001	8.97E-07	2.96E-06	1.74E-07	8.40E-07	6.00E-08
Cadmium	7.4	0.001	2.78E-07	9.17E-07	5.40E-08	2.60E-07	1.86E-08
Manganese	826	0.001	3.10E-05	1.02E-04	6.03E-06	2.90E-05	2.07E-06
Vanadium	84.5	0.001	3.17E-06	1.05E-05	6.17E-07	2.97E-06	2.12E-07

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.13.20
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	2E-05	7.7	0.016	0.15	9.0E-07	0.015	1.2E-07
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	5.4E-06	ND	7.4E-07
4,4'-DDE	NA	0.34	ND	ND	2.6E-07	ND	3.5E-08
Aluminum	1	NA	0.015	0.14	ND	0.014	ND
Arsenic	0.0003	1.5	0.036	0.34	6.0E-06	0.034	8.2E-07
Cadmium	0.001	NA	0.003	0.03	ND	0.003	ND
Manganese	0.14	NA	0.003	0.03	ND	0.003	ND
Vanadium	0.007	NA	0.006	0.05	ND	0.005	ND
SUM Hazard Index/ILCR			0.1	1	1E-05	0.07	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.13.21
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	0.5	1E-05	15.4	0.0261	0.086	7.8E-07	0.024	2.7E-07
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	4.7E-06	ND	1.6E-06
4,4'-DDE	0.5	NA	0.68	ND	ND	2.2E-07	ND	7.6E-08
Aluminum	0.2	0.2	NA	0.0060	0.020	ND	0.006	ND
Arsenic	0.2	6E-05	7.5	0.0150	0.049	1.3E-06	0.014	4.5E-07
Cadmium	0.2	0.0002	NA	0.0014	0.005	ND	0.001	ND
Manganese	0.2	0.028	NA	0.0011	0.004	ND	0.001	ND
Vanadium	0.2	0.0014	NA	0.0023	0.007	ND	0.002	ND
SUM Hazard Index/ILCR				0.052	0.2	7E-06	0.05	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.13.22
Central Tendency Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Benzene	0.16	1.54E-03	5.13E-03	2.97E-04	1.03E-03	7.35E-05
2,3,7,8-TCDD Equivalents	1.33E-09	1.28E-11	4.26E-11	2.47E-12	8.55E-12	6.11E-13

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.13.23
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzene	0.0003	0.029	5.1	17.1	8.6E-06	3.4	2.1E-06
2,3,7,8-TCDD Equivalents	NA	150000	ND	ND	3.7E-07	ND	9.2E-08
SUM Hazard Index/ILCR			5	17	9E-06	3	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.13.24
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzene	0.00171	0.029	0.9	3.0	8.6E-06	0.6	2.1E-06
SUM Hazard Index/ILCR			0.9	3	9E-06	0.6	2E-06

NOTES:

- NA Not available
- ND Not Determined due to lack of available information
- lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
- ILCR Incremental Lifetime excess Cancer Risk

ble 6.2.13.25 Exposure Pathway Summary of Carcinogenic
k and Non-carcinogenic Hazard
C 663/SWMU 136
val Base Charleston
arleston, SC

Medium/Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotien	Potential Future Resident lwa ILCR	Site HQ	Worker ILCR
face Soil	Incidental Ingestion	0.2	2	1E-04	0.08	1E-05
	Dermal Contact	0.08	0.3	3E-05	0.055	1E-05
allow Groundwater	Ingestion	15	34	7E-05	5	2E-05
	Inhalation	3	6	7E-05	1	2E-05
n of All Pathways		17	43	3E-04	7	6E-05

tes:
indicates not determined due to lack of available risk information.
R indicates incremental excess lifetime cancer risk.
indicates hazard index.

Table 6.2.13.26
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 663/SWMU 136 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	**Hazard-Based Remedial Goal Options** **0.1** mg/kg	**1.0** mg/kg	**3** mg/kg	**Risk-Based Remedial Goal Options** **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Aroclor-1254	7.7	2E-05	0.695	0.12	1.2	4	0.057	0.57	5.7	ND
Benzo(a)pyrene equivalents	7.3	NA	4.42	ND	ND	ND	0.060	0.60	6.0	ND
4,4'-DDE	0.34	NA	4.48	ND	ND	ND	1.296	12.96	129.6	ND
Aluminum	NA	1	31900	7293	72927	218781	ND	ND	ND	25310
Arsenic	1.5	0.0003	23.9	2	22	66	0.383	3.83	38.3	14.81
Cadmium	NA	0.001	7.4	7	73	219	ND	ND	ND	1.05
Manganese	NA	0.14	826	1021	10209.8	30629	ND	ND	ND	636.4
Vanadium	NA	0.007	84.5	51.0	510.5	1531	ND	ND	ND	77.38

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.13.27
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 663 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene	7.3	NA	4.48	0.30	3.0	30	ND
Arsenic	1.5	0.0003	**23.9**	9.6	96	957	14.81

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.13.28
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 663/SWMU 136 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	ARAR mg/l	Background Concentration mg/l
Benzene	0.029	0.0003/0.00171	0.16	0.0004	0.004	0.01	0.001	0.01	0.11	0.005	ND
2,3,7,8-TCDD Equivalents	150000	NA	1.33E-09	ND	ND	ND	4.42E-10	4.4E-09	4.4E-08	3E-08	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
- The concentration reported for dioxin in groundwater is an order of magnitude less than the corresponding ARAR, which would be the most appropriate remedial goal option.

Table 6.2.13.29
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 663/SWMU 136 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	ARAR mg/l	Background Concentration mg/l
Benzene	0.029	0.0003/0.00171	0.16	0.003	0.03	0.08	0.005	0.05	0.49	0.005	ND
2,3,7,8-TCDD Equivalents	150000	NA	1.33E-09	ND	ND	ND	1.91E-09	1.9E-08	1.9E-07	3E-08	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- The concentration reported for dioxin in groundwater is an order of magnitude less than the corresponding ARAR, which would be the most appropriate remedial goal option.

Table 6.2.13.1
Methods Run at AOC 663 (Includes SWMU 136)
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
136	B002	S	S	S	Y					S	Y					
136	B003	S	S							S						
136	B004	S	S							S						
663	B001	S	S	S	Y					S	Y					
663	B002	B	B	B	Y	Y	Y	Y	A	B	B					
663	B004	S	S	S	Y					S	Y					
663	B005	S	S	S	Y					S	Y					
663	B006	S	S							S						
663	B007	S	S							S						
663	B009		S													
663	B04A													Y	Y	Y
663	B05A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

- Y: Analyzed for standard list
- S: Analyzed for parameters on SW-846 list
- A: Analyzed for parameters on Appendix IX list
- B: Analyzed for parameters on both the SW-846 and Appendix IX lists

Blank value indicates this method of analysis was not performed

Table 6.2.13.2
Methods Run at AOC 663 (Includes SWMU 136)
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
136	W001	S	S	S	Y					S	Y					
663	W001	B	B	B	Y	Y	Y	Y	A	B	B					
663	W002	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.13.3
Methods Run at AOC 663 (Includes SWMU 136)
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
136	W001	S	S	S												
663	W001	S	S	S					S							
663	W002	S	S	S					S							

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.13.4
AOC 663 (Includes SWMU 136)
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthylene	UG/KG	1/ 10	330.00 - 550.00	1600.000 - 1600.000	1600.000	470000.0000[e]			
* Aluminum	MG/KG	9/ 9		724.000 - 31900.000	7676.000	7800.0000	1	25310.000	1
Anthracene	UG/KG	3/ 10	400.00 - 550.00	43.900 - 2200.000	774.866	2300000.0000			
* Aroclor-1254	UG/KG	1/ 9	33.00 - 78.00	695.000 - 695.000	695.000	83.0000	1		
* Arsenic	MG/KG	9/ 9		3.300 - 23.900	9.444	0.3700	9	14.810	2
delta-BHC	UG/KG	1/ 9	1.70 - 5.00	4.000 - 4.000	4.000	490.0000[l]			
Barium	MG/KG	5/ 9	7.30 - 38.00	9.500 - 29.900	19.160	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	4/ 10	400.00 - 550.00	139.500 - 780.000	523.625	310000.0000[f]			
* Benzo(a)pyrene Equivalents	UG/KG	10/ 10		85.293 - 4422.560	692.566	88.0000	5		
Benzo(a)anthracene	UG/KG	5/ 10	400.00 - 550.00	69.800 - 1400.000	468.120				
Benzo(b)fluoranthene	UG/KG	5/ 10	400.00 - 550.00	168.000 - 6300.000	1720.200				
Chrysene	UG/KG	5/ 10	400.00 - 550.00	82.100 - 3500.000	954.120				
Dibenzo(a,h)anthracene	UG/KG	3/ 10	400.00 - 550.00	49.300 - 350.000	237.433				
Indeno(1,2,3-cd)pyrene	UG/KG	4/ 10	400.00 - 550.00	124.050 - 980.000	531.762				
Benzo(k)fluoranthene	UG/KG	1/ 10	400.00 - 550.00	212.000 - 212.000	212.000				
Benzo(a)pyrene	UG/KG	5/ 10	400.00 - 550.00	82.900 - 3200.000	882.680				
Beryllium	MG/KG	9/ 9		0.105 - 1.400	0.421	0.1500	8	1.470	
* Cadmium	MG/KG	7/ 9	0.14 - 1.50	0.180 - 7.400	1.438	3.9000	1	1.050	1
Calcium	MG/KG	9/ 9		3200.000 - 411000.000	84276.666				
alpha-Chlordane	UG/KG	5/ 9	3.60 - 103.00	3.000 - 389.000	88.000	470.0000			
gamma-Chlordane	UG/KG	5/ 9	3.60 - 154.00	6.000 - 423.000	98.120	470.0000			
Chromium	MG/KG	9/ 9		8.100 - 54.300	24.872	39.0000	2	85.650	
Cobalt	MG/KG	9/ 9		1.100 - 8.300	3.066	470.0000		5.860	1
Copper	MG/KG	5/ 9	5.80 - 10.40	1.500 - 67.250	28.250	290.0000		27.600	2
4,4'-DDD	UG/KG	5/ 9	7.20 - 10.00	14.900 - 1940.000	419.660	2700.0000			
* 4,4'-DDE	UG/KG	8/ 9	4.00 - 4.00	3.000 - 4480.000	631.037	1900.0000	1		
4,4'-DDT	UG/KG	6/ 9	8.00 - 10.00	12.800 - 1390.000	267.083	1900.0000			
Di-n-butylphthalate	UG/KG	1/ 10	330.00 - 550.00	40.900 - 40.900	40.900	780000.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1		4.929 - 4.929	4.929	1000.0000			
Endosulfan I	UG/KG	1/ 9	1.70 - 5.00	10.000 - 10.000	10.000	47000.0000			
Endrin	UG/KG	1/ 9	3.30 - 5.00	7.950 - 7.950	7.950	2300.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	4/ 10	400.00 - 550.00	61.900 - 904.000	290.675	46000.0000			
Fluoranthene	UG/KG	8/ 10	400.00 - 550.00	48.800 - 1970.000	609.412	310000.0000			
Fluorene	UG/KG	1/ 10	330.00 - 550.00	160.000 - 160.000	160.000	310000.0000			

Table 6.2.13.4
AOC 663 (Includes SWMU 136)
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Heptachlor epoxide	UG/KG	3/ 9	3.60 -	5.00	3.000 -	31.100	13.563	70.0000			
Iron	MG/KG	9/ 9			4030.000 -	37700.000	11093.333			30910.000	1
Lead	MG/KG	7/ 9	1.30 -	16.00	22.600 -	118.000	54.321	400.0000j		118.000	1
Magnesium	MG/KG	9/ 9			358.000 -	3710.000	1701.666			9592.000	
* Manganese	MG/KG	9/ 9			28.200 -	826.000	170.933	39.0000	7	636.400	1
Mercury	MG/KG	4/ 9	0.03 -	0.03	0.030 -	0.190	0.122	2.3000		0.490	
Methylene chloride	UG/KG	1/ 5	12.00 -	13.00	11.200 -	11.200	11.200	85000.0000			
Nickel	MG/KG	6/ 9	5.40 -	7.80	6.400 -	17.100	10.633	160.0000		33.380	
Phenanthrene	UG/KG	4/ 10	400.00 -	550.00	41.300 -	608.000	228.325	310000.0000k			
Potassium	MG/KG	3/ 9	261.00 -	579.00	309.000 -	2100.000	1136.333				
Pyrene	UG/KG	6/ 10	400.00 -	550.00	90.000 -	3400.000	953.983	230000.0000			
Selenium	MG/KG	2/ 9	0.29 -	0.68	0.340 -	0.510	0.425	39.0000		2.000	
Sodium	MG/KG	9/ 9			60.700 -	214.000	142.444				
2,4,5-TP (Silvex)	UG/KG	1/ 1			7.300 -	7.300	7.300	63000.0000			
* Petroleum Hydrocarbons, TPH	MG/KG	4/ 5	71.00 -	71.00	73.000 -	190.000	145.750	10.0000	4		
Tin	MG/KG	1/ 1			2.000 -	2.000	2.000	4700.0000			
* Vanadium	MG/KG	9/ 9			4.400 -	84.500	25.666	55.0000	1	77.380	1
Zinc	MG/KG	7/ 9	15.70 -	27.90	48.400 -	816.000	218.128	2300.0000		214.300	1

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- e Acenaphthene used as surrogate
- f Fluoranthene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate
- l gamma-BHC (Lindane) used as surrogate

Table 6.2.13.5
AOC 663 (Includes SWMU 136)
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	UG/L	1/ 3	15.10 - 15.10	984.000 - 984.000	984.000	3700.0000			
Arsenic	UG/L	1/ 3	7.80 - 16.50	7.100 - 7.100	7.100	0.0380	1	27.990	
Barium	UG/L	2/ 3	0.80 - 0.80	4.300 - 21.500	12.900	260.0000		323.000	
Calcium	UG/L	3/ 3		51700.000 - 131000.000	87466.666				
2,4-DB	UG/L	1/ 1		1.600 - 1.600	1.600	29.0000			
• Dioxin (TCDD TEQ)	PG/L	1/ 1		1.328 - 1.328	1.328	0.5000	1		
1234678-HpCDD	PG/L	1/ 1		5.585 - 5.585	5.585				
1234789-HpCDF	PG/L	1/ 1		0.548 - 0.548	0.548				
123678-HxCDD	PG/L	1/ 1		1.397 - 1.397	1.397				
234678-HxCDF	PG/L	1/ 1		0.769 - 0.769	0.769				
OCDD	PG/L	1/ 1		17.674 - 17.674	17.674				
OCDF	PG/L	1/ 1		2.908 - 2.908	2.908				
12378-PeCDD	PG/L	1/ 1		1.918 - 1.918	1.918				
2378-TCDF	PG/L	1/ 1		0.712 - 0.712	0.712				
Iron	UG/L	3/ 3		1530.000 - 8500.000	4133.333				
Magnesium	UG/L	3/ 3		9270.000 - 63100.000	30056.666				
Manganese	UG/L	3/ 3		29.200 - 548.000	242.066	18.0000	3	3391.000	
Potassium	UG/L	3/ 3		11600.000 - 41400.000	22000.000				
Sodium	UG/L	3/ 3		83100.000 - 577000.000	268033.333				

Notes:

- • Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.13.6
AOC 663 (Includes SWMU 136)
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Aluminum	UG/L	2/ 3	15.40 - 15.40	17.900 - 1700.000	858.950	3700.0000			
Arsenic	UG/L	1/ 3	3.20 - 4.40	12.200 - 12.200	12.200	0.0380	1	27.990	
Barium	UG/L	3/ 3		2.500 - 19.300	9.133	260.0000		323.000	
* Benzene	UG/L	1/ 3	5.00 - 5.00	160.000 - 160.000	160.000	0.3460	1		
Calcium	UG/L	3/ 3		42800.000 - 109000.000	77333.333				
Ethylbenzene	UG/L	1/ 3	5.00 - 5.00	19.000 - 19.000	19.000	130.0000			
Iron	UG/L	3/ 3		2970.000 - 7130.000	4420.000				
Magnesium	UG/L	3/ 3		11400.000 - 61550.000	32150.000				
Manganese	UG/L	3/ 3		41.500 - 539.000	249.166	18.0000	3	3391.000	
Phenol	UG/L	1/ 3	11.00 - 11.00	7.200 - 7.200	7.200	2200.0000			
Potassium	UG/L	3/ 3		11700.000 - 37750.000	21516.666				
Sodium	UG/L	3/ 3		131000.000 - 370000.000	219000.000				
Toluene	UG/L	1/ 3	5.00 - 5.00	37.000 - 37.000	37.000	75.0000			
Vanadium	UG/L	1/ 3	2.50 - 2.50	7.000 - 7.000	7.000	26.0000			
Xylene (total)	UG/L	1/ 3	5.00 - 5.00	26.000 - 26.000	26.000	1200.0000			
Zinc	UG/L	1/ 3	5.80 - 5.80	10.600 - 10.600	10.600	1100.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.13.7
Exposure Pathways Summary — AOC 663
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 663.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 663.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	CPSSs were greater than RBC and Reference concentrations.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.

Table 6.2.13.7
Exposure Pathways Summary — AOC 663
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.13.8
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	0.695	9.52E-07	8.89E-06	1.09E-06	3.40E-07	1.21E-07
Benzo(a)pyrene equivalents	4.42	6.05E-06	5.65E-05	6.92E-06	2.16E-06	7.72E-07
4,4'-DDE	4.48	6.14E-06	5.73E-05	7.01E-06	2.19E-06	7.83E-07
Aluminum	31900	4.37E-02	4.08E-01	4.99E-02	1.56E-02	5.57E-03
Arsenic	23.9	3.27E-05	3.06E-04	3.74E-05	1.17E-05	4.18E-06
Cadmium	7.4	1.01E-05	9.46E-05	1.16E-05	3.62E-06	1.29E-06
Manganese	826	1.13E-03	1.06E-02	1.29E-03	4.04E-04	1.44E-04
Vanadium	84.5	1.16E-04	1.08E-03	1.32E-04	4.13E-05	1.48E-05

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 6.2.13.9
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	0.695	0.01	3.90E-07	1.29E-06	2.44E-07	2.79E-07	9.96E-08
Benzo(a)pyrene equivalents	4.42	0.01	2.48E-06	8.19E-06	1.55E-06	1.77E-06	6.33E-07
4,4'-DDE	4.48	0.01	2.52E-06	8.31E-06	1.57E-06	1.80E-06	6.42E-07
Aluminum	31900	0.001	1.79E-03	5.91E-03	1.12E-03	1.28E-03	4.57E-04
Arsenic	23.9	0.001	1.34E-06	4.43E-06	8.40E-07	9.59E-07	3.42E-07
Cadmium	7.4	0.001	4.16E-07	1.37E-06	2.60E-07	2.97E-07	1.06E-07
Manganese	826	0.001	4.64E-05	1.53E-04	2.90E-05	3.31E-05	1.18E-05
Vanadium	84.5	0.001	4.75E-06	1.57E-05	2.97E-06	3.39E-06	1.21E-06

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.13.10
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Vinyl chloride	0.0021	5.75E-05	1.34E-04	3.16E-05	2.14E-05	7.63E-06
Chloromethane	0.006	1.64E-04	3.84E-04	9.04E-05	6.11E-05	2.18E-05

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.13.10
Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Benzene	0.16	4.38E-03	1.02E-02	2.41E-03	1.63E-03	5.81E-04
2,3,7,8-TCDD Equivalents	1.33E-09	3.64E-11	8.50E-11	2.00E-11	1.35E-11	4.83E-12

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

able 6.2.13.11
azard Quotients and Incremental Lifetime Cancer Risks
halation of Contaminants Volatilized from Shallow Groundwater
OC 663/SWMU 136
aval Base Charleston
harleston, SC

hemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
enzene	0.00171	0.029	2.6	6.0	7.0E-05	0.9	1.6E-05
UM Hazard Index/ILCR			3	6	7E-05	0.9	2E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

ıble 6.2.13.12 - AOC 663
›xicological Database Information
: Chemicals of Potential Concern
ΛVBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

ıemical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation
uminum	1	e			ND	ND				ND
senic	0.0003	a	M	hyperpigmentation	3	ND				ND
ıdmium (food)	0.001	a	H	proteinuria	10	ND				ND
ıdmium (water)	0.0005	a	H	proteinuria	10	ND				ND
ınganese (water)	0.005	a	NA	neurological effects	1	1.43E-05	a	M	neurological effects	1000
ınganese (food)	0.14	a	NA	neurological effects	1	ND				ND
:B Aroclor-1254	2E-05	a	NA		ND	ND				ND
ınzo(a)pyrene Equivalents	ND				ND	ND				ND
l'-DDE	ND				ND	ND				ND
ınadium	0.007	a		unclear	100	ND				ND
ınzene	ND				ND	0.00171	e	NA		ND
3,7,8-TCDD	ND				ND	ND				ND

NOTES:

a Integrated Risk Information System (IRIS)
b Health Effects Assessment Summary Tables (HEAST)
e EPA Environmental Criteria and Assessment Office - Cincinnati (provisional)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

ble 6.2.13.12 - AOC 663
xicological Database Information
Chemicals of Potential Concern
.VBASE Charleston, Zone H

Carcinogenic Toxicity Data

emical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
ıminum	ND		ND		ND	
senic	1.5	a	15.1	a	A	various
ıdmium (food)	ND		6.3	a	B1	lung
ıdmium (water)	ND		6.3	a	B1	lung
ınganese (water)	ND		ND		D	
ınganese (food)	ND		ND		D	
;B Aroclor-1254	7.7		ND		B2	hepatocellular carcinoma
nzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
ı'-DDE	0.34	a	ND		B2	liver
nadium	ND		ND		D	
nzene	0.029	a	0.029	a	A	leukemia
ȝ,7,8-TCDD	150000	b			B2	mutagen and teratogen

Table 6.2.13.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	2E-05	7.7	0.048	0.44	8.4E-06	0.017	9.4E-07
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	5.1E-05	ND	5.6E-06
4,4′-DDE	NA	0.34	ND	ND	2.4E-06	ND	2.7E-07
Aluminum	1	NA	0.044	0.41	ND	0.016	ND
Arsenic	0.0003	1.5	0.109	1.02	5.6E-05	0.039	6.3E-06
Cadmium	0.001	NA	0.010	0.09	ND	0.004	ND
Manganese	0.14	NA	0.008	0.08	ND	0.003	ND
Vanadium	0.007	NA	0.017	0.15	ND	0.006	ND
SUM Hazard Index/ILCR			0.2	2	1E-04	0.08	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.13.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	0.5	1E-05	15.4	0.0390	0.129	3.8E-06	0.028	1.5E-06
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	2.3E-05	ND	9.2E-06
4,4'-DDE	0.5	NA	0.68	ND	ND	1.1E-06	ND	4.4E-07
Aluminum	0.2	0.2	NA	0.0090	0.030	ND	0.006	ND
Arsenic	0.2	6E-05	7.5	0.0224	0.074	6.3E-06	0.016	2.6E-06
Cadmium	0.2	0.0002	NA	0.0021	0.007	ND	0.001	ND
Manganese	0.2	0.028	NA	0.0017	0.005	ND	0.001	ND
Vanadium	0.2	0.0014	NA	0.0034	0.011	ND	0.002	ND
SUM Hazard Index/ILCR				0.077	0.3	3E-05	0.06	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.13.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzene	0.0003	0.029	14.6	34.1	7.0E-05	5.4	1.7E-05
2,3,7,8-TCDD Equivalents	NA	150000	ND	ND	3.0E-06	ND	7.3E-07
SUM Hazard Index/ILCR			15	34	7E-05	5	2E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.13.16
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzene	0.00171	0.029	2.6	6.0	7.0E-05	1.0	1.7E-05
SUM Hazard Index/ILCR			3	6	7E-05	1	2E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

able 6.2.13.17 Summary of Carcinogenic Risk and Non-carcinogenic Hazard
nd Identification of Chemicals of Concern
OC 663/SWMU 136
aval Base Charleston
harleston, SC

edium/Pathway	Chemical	Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs			
il Incidental Ingestion	Aroclor-1254	0.048	0.44	8.4E-06	0.017	9.4E-07	1	2		
	Benzo(a)pyrene equivalents	ND	ND	5.1E-05	ND	5.6E-06		2		4
	4,4'-DDE	ND	ND	2.4E-06	ND	2.7E-07		2		
	Aluminum	0.044	0.41	ND	0.016	ND	1			
	Arsenic	0.109	1.02	5.6E-05	0.039	6.3E-06	1	2		4
	Cadmium	0.010	0.09	ND	0.004	ND				
	Manganese	0.008	0.08	ND	0.003	ND				
	Vanadium	0.017	0.15	ND	0.006	ND	1			
oil Incidental Ingestion Pathway Total		0.2	2	1E-04	0.08	1E-05				
il Dermal Contact Pathway	Aroclor-1254	0.0390	0.129	3.8E-06	0.028	1.5E-06		2		4
	Benzo(a)pyrene equivalents	ND	ND	2.3E-05	ND	9.2E-06		2		4
	4,4'-DDE	ND	ND	1.1E-06	ND	4.4E-07		2		
	Aluminum	0.0090	0.030	ND	0.006	ND				
	Arsenic	0.0224	0.074	6.3E-06	0.016	2.6E-06		2		4
	Cadmium	0.0021	0.007	ND	0.001	ND				
	Manganese	0.0017	0.005	ND	0.001	ND				
	Vanadium	0.0034	0.011	ND	0.002	ND				
il Dermal Contact Pathway Total		0.08	0.3	3E-05	0.055	1E-05				
allow/Intermediate Groundwater Ingestion Pathway	Benzene	14.6	34.1	7.0E-05	5.4	1.7E-05	1	2	3	4
	2,3,7,8-TCDD Equivalents	ND	ND	3.0E-06	ND	7.3E-07		2		
allow/Intermediate Groundwater Ingestion Pathway Total		15	34	7E-05	5	2E-05				
llow/Intermediate Groundwater Inhalation Pathway	Benzene	2.6	6.0	7.0E-05	1.0	1.7E-05	1	2		4
allow Groundwater Inhalation Pathway Total		3	6	7E-05	1	2E-05				
Pathways Cumulative Total Risk/Hazard		17	43	3E-04	7	6E-05				

TES are continued on the following page.

le 6.2.13.17 (continued)

TES:

indicates not applicable
A indicates lifetime weighted average
Chemical is a COC by virtue of projected child resident non-carcinogenic hazard.
Chemical is a COC by virtue of projected future resident lifetime weighted average carcinogenic risk.
Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
Chemical is a COC by virtue of projected site worker carcinogenic risk.
: concentration reported for dioxin in groundwater is approximately an order of magnitude less than the corresponding MCL.

Table 6.2.13.18
Central Tendency Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	0.695	3.18E-07	2.97E-06	1.17E-07	2.98E-07	1.60E-08
Benzo(a)pyrene equivalents	4.42	2.02E-06	1.89E-05	7.42E-07	1.89E-06	1.01E-07
4,4'-DDE	4.48	2.05E-06	1.91E-05	7.52E-07	1.92E-06	1.03E-07
Aluminum	31900	1.46E-02	1.36E-01	5.36E-03	1.37E-02	7.32E-04
Arsenic	23.9	1.09E-05	1.02E-04	4.01E-06	1.02E-05	5.49E-07
Cadmium	7.4	3.39E-06	3.16E-05	1.24E-06	3.17E-06	1.70E-07
Manganese	826	3.78E-04	3.53E-03	1.39E-04	3.54E-04	1.90E-05
Vanadium	84.5	3.87E-05	3.61E-04	1.42E-05	3.62E-05	1.94E-06

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 6.2.13.19
Central Tendency Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1254	0.695	0.01	2.61E-07	8.61E-07	5.07E-08	2.44E-07	1.74E-08
Benzo(a)pyrene equivalents	4.42	0.01	1.66E-06	5.48E-06	3.22E-07	1.55E-06	1.11E-07
4,4'-DDE	4.48	0.01	1.68E-06	5.55E-06	3.27E-07	1.57E-06	1.12E-07
Aluminum	31900	0.001	1.20E-03	3.95E-03	2.33E-04	1.12E-03	8.01E-05
Arsenic	23.9	0.001	8.97E-07	2.96E-06	1.74E-07	8.40E-07	6.00E-08
Cadmium	7.4	0.001	2.78E-07	9.17E-07	5.40E-08	2.60E-07	1.86E-08
Manganese	826	0.001	3.10E-05	1.02E-04	6.03E-06	2.90E-05	2.07E-06
Vanadium	84.5	0.001	3.17E-06	1.05E-05	6.17E-07	2.97E-06	2.12E-07

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.13.20
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	2E-05	7.7	0.016	0.15	9.0E-07	0.015	1.2E-07
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	5.4E-06	ND	7.4E-07
4,4'-DDE	NA	0.34	ND	ND	2.6E-07	ND	3.5E-08
Aluminum	1	NA	0.015	0.14	ND	0.014	ND
Arsenic	0.0003	1.5	0.036	0.34	6.0E-06	0.034	8.2E-07
Cadmium	0.001	NA	0.003	0.03	ND	0.003	ND
Manganese	0.14	NA	0.003	0.03	ND	0.003	ND
Vanadium	0.007	NA	0.006	0.05	ND	0.005	ND
SUM Hazard Index/ILCR			0.1	1	1E-05	0.07	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.13.21
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1254	0.5	1E-05	15.4	0.0261	0.086	7.8E-07	0.024	2.7E-07
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	4.7E-06	ND	1.6E-06
4,4'-DDE	0.5	NA	0.68	ND	ND	2.2E-07	ND	7.6E-08
Aluminum	0.2	0.2	NA	0.0060	0.020	ND	0.006	ND
Arsenic	0.2	6E-05	7.5	0.0150	0.049	1.3E-06	0.014	4.5E-07
Cadmium	0.2	0.0002	NA	0.0014	0.005	ND	0.001	ND
Manganese	0.2	0.028	NA	0.0011	0.004	ND	0.001	ND
Vanadium	0.2	0.0014	NA	0.0023	0.007	ND	0.002	ND
SUM Hazard Index/ILCR				0.052	0.2	7E-06	0.05	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.13.22
Central Tendency Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Benzene	0.16	1.54E-03	5.13E-03	2.97E-04	1.03E-03	7.35E-05
2,3,7,8-TCDD Equivalents	1.33E-09	1.28E-11	4.26E-11	2.47E-12	8.55E-12	6.11E-13

NOTES:

lwa	lifetime weighted average
CDI	Chronic Daily Intake
H-CDI	Non-carcinogenic hazard based Chronic Daily Intake
C-CDI	Carcinogenic risk based Chronic Daily Intake

Table 6.2.13.23
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzene	0.0003	0.029	5.1	17.1	8.6E-06	3.4	2.1E-06
2,3,7,8-TCDD Equivalents	NA	150000	ND	ND	3.7E-07	ND	9.2E-08
SUM Hazard Index/ILCR			5	17	9E-06	3	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.13.24
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater
AOC 663/SWMU 136
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Benzene	0.00171	0.029	0.9	3.0	8.6E-06	0.6	2.1E-06
SUM Hazard Index/ILCR			0.9	3	9E-06	0.6	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

ɔle 6.2.13.25 Exposure Pathway Summary of Carcinogenic
k and Non-carcinogenic Hazard
C 663/SWMU 136
ʋal Base Charleston
arleston, SC

Medium/Pathway		Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotien	Potential Future Resident lwa ILCR	Site Worker HQ	Site Worker ILCR
rface Soil	Incidental Ingestion	0.2	2	1E-04	0.08	1E-05
	Dermal Contact	0.08	0.3	3E-05	0.055	1E-05
allow Groundwater	Ingestion	15	34	7E-05	5	2E-05
	Inhalation	3	6	7E-05	1	2E-05
m of All Pathways		17	43	3E-04	7	6E-05

tes:
indicates not determined due to lack of available risk information.
:R indicates incremental excess lifetime cancer risk.
indicates hazard index.

Table 6.2.13.26
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 663/SWMU 136 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Hazard-Based Remedial Goal Options 0.1 mg/kg	1.0 mg/kg	3 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aroclor-1254	7.7	2E-05	0.695	0.12	1.2	4	0.057	0.57	5.7	ND
Benzo(a)pyrene equivalents	7.3	NA	4.42	ND	ND	ND	0.060	0.60	6.0	ND
4,4'-DDE	0.34	NA	4.48	ND	ND	ND	1.296	12.96	129.6	ND
Aluminum	NA	1	31900	7293	72927	218781	ND	ND	ND	25310
Arsenic	1.5	0.0003	23.9	2	22	66	0.383	3.83	38.3	14.81
Cadmium	NA	0.001	7.4	7	73	219	ND	ND	ND	1.05
Manganese	NA	0.14	826	1021	10209.8	30629	ND	ND	ND	636.4
Vanadium	NA	0.007	84.5	51.0	510.5	1531	ND	ND	ND	77.38

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.13.27
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 663 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene	7.3	NA	4.48	0.30	3.0	30	ND
Arsenic	1.5	0.0003	**23.9**	9.6	96	957	14.81

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.13.28
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 663/SWMU 136 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	ARAR mg/l	Background Concentration mg/l
Benzene	0.029	0.0003/0.00171	0.16	0.0004	0.004	0.01	0.001	0.01	0.11	0.005	ND
2,3,7,8-TCDD Equivalents	150000	NA	1.33E-09	ND	ND	ND	4.42E-10	4.4E-09	4.4E-08	3E-08	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens
- The concentration reported for dioxin in groundwater is an order of magnitude less than the corresponding ARAR, which would be the most appropriate remedial goal option.

Table 6.2.13.29
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 663/SWMU 136 Shallow Groundwater
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/l	**Hazard-Based Remedial Goal Options** **0.1** mg/l	**1.0** mg/l	**3** mg/l	**Risk-Based Remedial Goal Options** **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	ARAR mg/l	Background Concentration mg/l
Benzene	0.029	0.0003/0.00171	0.16	0.003	0.03	0.08	0.005	0.05	0.49	0.005	ND
2,3,7,8-TCDD Equivalents	150000	NA	1.33E-09	ND	ND	ND	1.91E-09	1.9E-08	1.9E-07	3E-08	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- The concentration reported for dioxin in groundwater is an order of magnitude less than the corresponding ARAR, which would be the most appropriate remedial goal option.

6.2.14 Baseline Risk Assessment for AOC 665

6.2.14.1 Site Background and Investigative Approach

AOC 665 was investigated to assess soil at the former site of a pyrotechnic storage shed present from 1993 until demolition at an unknown date. The types of pyrotechnic explosives stored there are known. Currently, Building 1889 and NS-46 occupy the shed's former site. Four soil samples were collected from the surface interval (0 to 1 foot deep). Table 6.2.14.1 also shows each surface soil designation and lists analytical methods used. Groundwater was not sampled onsite.

6.2.14.2 COPC Identification

Surface soil data and screening values used in the screening comparison for AOC 665 soil are summarized in Table 6.2.14.2. As shown in the table, BEQs were the only identified soil COPC. TPH was identified in two of four soil samples with the TPH concentration ranging from 94 to 200 mg/kg, which exceeds the NAVBASE soil AL of 100 mg/kg.

6.2.14.3 Exposure Assessment

Exposure Setting

The exposure setting at combined AOC 665 is currently office and training buildings. A pyrotechnic shed reportedly occupied the site from 1943 until it was demolished.

The site is anticipated to remain commercial/industrial property. AOC 665 is in an area proposed to become a marine cargo terminal under current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations include current and future site workers as well as hypothetical future site residents. Because many traditional activities at NAVBASE have ceased or are expected to cease in the near future, current site workers were not specifically addressed in the formal assessment. Due to the lack of specific knowledge regarding the functions that will be performed by future site workers, a standard default scenario was developed for these individuals. A similar approach was applied for future site residents.

Exposure Pathways

Exposure pathways for future site workers and site residents were based on an evaluation of the impacted media identified at AOC 665. Relative to the soil matrix, incidental ingestion and dermal contact were considered viable exposure pathways. Groundwater exposure pathways were not considered because no COPCs were identified. Uniform exposure was assumed for all sample locations. Table 6.2.14.3 presents the exposure pathway selection process and justifies each pathway evaluated.

Exposure Point Concentrations

At AOC 665, fewer than 10 samples were collected from each potential exposure medium. As a result, the maximum concentration of each COPC identified in soil was used as the EPC.

Quantification of Exposure

Soil

Tables 6.2.14.4 and 6.2.14.5 present the CDI for the ingestion and dermal contact pathways.

6.2.14.4 Toxicity Assessment

Carcinogenic PAHs were the only COPCs identified at AOC 665. The following summarizes the risk/hazard for the compound group.

Polyaromatic hydrocarbons include the following compounds:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0

Future Site Workers

The projected ingestion related ILCR from surface soil was 1.9E-7, and the dermal pathway risk was 3.1E-7. BEQs were the only contributors for both pathways. No reference dose is available for BAP, thus no HQs were computed.

Because site worker risk projections did not exceed the most conservative 1E-6 point of departure, assuming that all surface soil was accessible for contact exposure, no formal assessment was performed considering the influences of site features. The maximally impacted surface soil sample (location 665SB002) was collected directly beneath an asphalt parking surface. If the parking lot remains intact, direct soil exposure will be prevented under typical worker exposure conditions.

COCs Identified

COCs were identified based on soil pathway risk and hazard projected for the site. BEQs were the only COCs in AOC 665. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is comparatively conservative as USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection algorithm more comprehensively evaluates chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

The soil exposure scenarios were maintained in both instances. Under the traditional risk-based COC trigger provisions, no carcinogenic COCs would be identified under the hypothetical residential use scenario for soil because the cumulative risk is well below 1E-4.

Surface Soil

Hypothetical Site Residents

BEQs were identified as COCs for this scenario based on their contribution to risk/hazard.

Hypothetical Site Workers

No COCs were identified for this scenario based on the sum ILCR and HI.

Due to the limited extent of identified soil impacts, graphical presentation of risk projections for SWMU 665 surface soil were of limited use. Alternatively, the extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential RGO were compared to each reported concentration for the COCs identified above. Calculation of the RGOs used for this comparison was based on an ILCR of 1E-6. BEQs were reported at a concentration in excess of the corresponding RGO at two sample locations which were also the only locations at which they were detected (two of four surface soil samples). The maximum BEQs were detected in sample 665SB002 (0.151 mg/kg), which was collected from directly beneath an asphalt parking lot.

6.2.14.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions in the site worker scenario are highly protective and would tend to overestimate exposure. Under current site use conditions, workers are not exposed to surface soil sampled during the RFI when walking across the site or using the buildings and parking lot because the area in question is beneath an asphalt parking lot.

Residential use of the site would not be expected, based on current uses and the nature of surrounding buildings. Plans call for continued use as nonresidential maintenance property, specifically a marine cargo terminal. To develop the site for residential purposes, the asphalt parking surface would be removed. There is a high probability that the cPAHs detected in surface soil are associated with this overlying material. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

The maximum concentration reported for BEQs was used as the EPC for this site. As a result, the quantification of exposure does not account for potential variability in the contaminant concentrations in the soil matrix.

Frequency of Detection and Spatial Distribution

The use of the maximum concentration as a EPC is questionable for the COCs at this site, and the calculated risk and hazard could be skewed up or down because of the low frequency of detection. The biased sampling approach skewed high.

BEQs reported in surface soil at combined AOC 665 deserve further mention because they were detected in only two of the four samples. As a result, the potential for chronic exposure is considered low. Therefore, risk projected in this assessment is considered an overestimate. The only BEQ hits were J qualified; therefore, confidence in the quantitation is relatively low. If frequency of detection was used to estimate the fraction ingested from contaminated source and fraction contacted from contaminated source terms, the soil pathway ILCR would be just above 1E-6, assuming all other conditions and assumptions remain constant.

Elevated TPH results (94 to 200 mg/kg) were reported in soil onsite. No groundwater sample contained detectable concentrations of TPH, indicating that the shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of TPH constituents.

Quantification of Risk/Hazard

As indicated, the uncertainty inherent in risk assessment is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC, reducing the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of aluminum, arsenic, beryllium, and manganese exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding reference concentrations. Therefore, they were eliminated from formal assessment based on comparisons to the reference concentrations because they did not contribute to excess risk/hazard at the site.

The sample in which BEQs were detected was collected directly beneath an asphalt covered lot. BAP and other cPAHs are constituents of asphalt and their presence is not necessarily attributable to past or current site operation. The former operations at AOC 665 included pyrotechnic explosives storage, which would not be expected to be a source of BEQ compounds.

Both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard. A map was not produced for this site.

The CT assumption for residential exposure duration is nine years compared to the 30-year assumption for RME. If all other exposure assumptions remain fixed, application of the CT exposure duration would result in risk projections 66% below the RME. At CT, the surface soil-related risk (incidental ingestion and dermal contact) would fall below the 1E-6 point of departure.

6.2.14.7 Risk Summary

The risk and hazard posed by contaminants at AOC 665 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 6.2.14.8 summarizes risk for the combined incidental ingestion and dermal pathways for AOC 665.

6.2.14.8 Remedial Goal Options

Soil

RGOs for the hypothetical site residential scenario at AOC 665 were calculated for BAP, as shown in Table 6.2.14.9. Inclusion in an RGO table does not necessarily indicate that remedial action is warranted. RGOs are options to be considered when making risk management decisions which, in accordance with RAGS, are not to be included in HHRAs.

Table 6.2.14.1
Methods Run at AOC 665
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
665	B001	S	S	S	Y					S	Y					
665	B002	S	S	S	Y					S	Y					
665	B003	S	S	S	Y					S	Y					
665	B004	S	S	S	Y					S	Y					
665	B03A													Y	Y	Y

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.14.2
AOC 665
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	2/ 4	27.00 -	27.00	34.000 -	210.000	122.000	780000.0000			
Aluminum	MG/KG	4/ 4			4540.000 -	8000.000	6325.000	7800.0000	1	25310.000	
Anthracene	UG/KG	1/ 4	370.00 -	380.00	150.000 -	150.000	150.000	2300000.0000			
Arsenic	MG/KG	4/ 4			1.300 -	7.900	4.875	0.3700	4	14.810	
Barium	MG/KG	4/ 4			8.000 -	14.100	12.075	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	1/ 4	370.00 -	380.00	100.000 -	100.000	100.000	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	4/ 4			57.885 -	154.720	92.731	88.0000	2		
Benzo(a)anthracene	UG/KG	1/ 4	370.00 -	370.00	170.000 -	170.000	170.000				
Benzo(b)fluoranthene	UG/KG	1/ 4	370.00 -	370.00	120.000 -	120.000	120.000				
Chrysene	UG/KG	1/ 4	370.00 -	370.00	170.000 -	170.000	170.000				
Indeno(1,2,3-cd)pyrene	UG/KG	1/ 4	370.00 -	380.00	81.000 -	81.000	81.000				
Benzo(k)fluoranthene	UG/KG	1/ 4	370.00 -	370.00	150.000 -	150.000	150.000				
Benzo(a)pyrene	UG/KG	2/ 4	370.00 -	370.00	77.000 -	120.000	98.500				
Beryllium	MG/KG	4/ 4			0.040 -	0.240	0.147	0.1500	2	1.470	
Cadmium	MG/KG	1/ 4	0.17 -	0.18	0.810 -	0.810	0.810	3.9000		1.050	
Calcium	MG/KG	4/ 4			1200.000 -	23400.000	10155.000				
alpha-Chlordane	UG/KG	3/ 4	4.00 -	4.00	3.000 -	11.000	6.333	470.0000			
gamma-Chlordane	UG/KG	3/ 4	4.00 -	4.00	4.000 -	18.000	8.666	470.0000			
Chromium	MG/KG	4/ 4			5.900 -	17.400	12.100	39.0000		85.650	
Cobalt	MG/KG	4/ 4			1.100 -	1.600	1.350	470.0000		5.860	
Copper	MG/KG	4/ 4			1.600 -	39.100	18.675	290.0000		27.600	2
4,4'-DDE	UG/KG	3/ 4	4.00 -	4.00	4.000 -	8.000	6.000	1900.0000			
4,4'-DDT	UG/KG	3/ 4	7.00 -	7.00	10.000 -	13.000	12.000	1900.0000			
Endosulfan II	UG/KG	1/ 4	7.00 -	8.00	4.000 -	4.000	4.000	47000.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	1/ 4	370.00 -	380.00	130.000 -	130.000	130.000	46000.0000			
Fluoranthene	UG/KG	1/ 4	370.00 -	370.00	370.000 -	370.000	370.000	310000.0000			
Heptachlor epoxide	UG/KG	1/ 4	4.00 -	4.00	8.000 -	8.000	8.000	70.0000			
Iron	MG/KG	4/ 4			2430.000 -	8510.000	5307.500			30910.000	
Lead	MG/KG	4/ 4			4.300 -	51.400	19.150	400.0000j		118.000	
Magnesium	MG/KG	4/ 4			161.000 -	908.000	586.000			9592.000	
Manganese	MG/KG	4/ 4			5.900 -	63.900	34.100	39.0000	1	636.400	
Mercury	MG/KG	3/ 4	0.03 -	0.03	0.030 -	0.100	0.060	2.3000		0.490	
Nickel	MG/KG	4/ 4			1.600 -	10.100	5.175	160.0000		33.380	
Phenanthrene	UG/KG	1/ 4	370.00 -	370.00	320.000 -	320.000	320.000	310000.0000k			

Table 6.2.14.2
AOC 665
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Pyrene	UG/KG	1/ 4	370.00 -	370.00	280.000 -	280.000	280.000	230000.0000			
Sodium	MG/KG	4/ 4			27.100 -	246.000	106.950				
* Petroleum Hydrocarbons, TPH	MG/KG	2/ 4	65.00 -	67.00	94.000 -	200.000	147.000	10.0000	2		
Toluene	UG/KG	2/ 4	6.00 -	6.00	3.900 -	4.200	4.050	1600000.0000			
Vanadium	MG/KG	4/ 4			10.200 -	36.900	21.050	55.0000		77.380	
Zinc	MG/KG	2/ 4	5.30 -	16.80	23.000 -	111.000	67.000	2300.0000		214.300	

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- f Fluoranthene used as surrogate
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.14.3
Exposure Pathways Summary — AOC 665
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for SWMU 665, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 665.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 665.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for SWMU 665, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Risk-based screening was performed on shallow groundwater data. No COPCs were identified at this site. Therefore, shallow groundwater was not addressed formally.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Risk-based screening was performed on shallow groundwater data. No VOCs were identified as shallow groundwater COPCs at this site.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.

Table 6.2.14.3
Exposure Pathways Summary — AOC 665
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.14.4
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 665
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene equivalents	1	0.151	2.07E-07	1.93E-06	2.36E-07	7.39E-08	2.64E-08

NOTES:

TEF	toxic equivalency factor relative to Benzo(a)pyrene
lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk

Table 6.2.14.5
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 665
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene equivalents	1	0.151	0.01	8.48E-08	2.80E-07	5.31E-08	6.06E-08	2.16E-08

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.14.6
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 665
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	1.7E-06	ND	1.9E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.14.7
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 665
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	7.7E-07	ND	3.2E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.14.8
Summary of Risk and Hazard for AOC 665
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	1.7E-06	ND	1.9E-07
	Dermal Contact	ND	ND	7.7E-07	ND	3.2E-07

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 6.2.14.9
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 665 Surface Soils
Charleston, South Carolina

				Hazard-Based Remedial Goal Options			**Risk-Based Remedial Goal Options**			
Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	**3** mg/kg	**1** mg/kg	**0.1** mg/kg	**1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Benzo(a)pyrene equivalents	7.3	NA	0.151	ND	ND	ND	0.060	0.60	6.0	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs also set by USEPA, are multipliers applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the B2 classification is based on insufficient human data specifically linking BAP to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question; the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and is presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in

1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the B2 classification of dibenz(a,h)anthracene, benzo(b), and benzo(b)fluoranthene is based on no human data but sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. It also mutates in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene***, ***acenaphthene***, ***acenaphthylene***, ***benzo(g,h,i)perylene***, and ***phenanthrene***. USEPA determined RfDs for only two of these compounds. Pyrene's RfD_o of 0.03 mg/kg-day is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene is 0.06 mg/kg-day.

6.2.14.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Tables 6.2.14.6 and 6.2.14.7 present the computed carcinogenic risk and noncarcinogenic HQs associated with the incidental ingestion and dermal contact with surface soil.

Future Site Residents

The projected ingestion related ILCR from surface soil was 1.7E-6, and the dermal pathway risk was 7.7E-7. BEQs were the only contributors for both pathways. No reference dose is available for BAP; thus no HQs were computed.

6.2.15 Baseline Risk Assessment for AOC 666

6.2.15.1 Site Background and Investigative Approach

AOC 666 was investigated to assess soil and groundwater near a UST (unknown capacity) which supplies No. 2 fuel oil to a heating plant (Facility NS-44). Before the site was constructed in 1958, the surrounding area was an airstrip.

Samples were collected from surface soil (0 to 1 foot deep) at seven locations. Table 6.2.15.1 lists the sample locations and analytical methods for the corresponding samples. Two shallow groundwater monitoring wells were installed and sampled. Tables 6.2.15.2 and 6.2.15.3 list the sample locations and analytical methods used for the first and second quarter, respectively.

6.2.15.2 COPC Identification

Soil

Based on the screening comparisons shown in Table 6.2.15.4 and discussed in Section 6.1.3.4 of this report, the following COPCs were identified for the soil exposure pathways: PCB Aroclor-1260, arsenic, BEQs, mercury, N-nitroso-di-n-propylamine, and vanadium. Wilcoxon rank sum test results indicate that, of the three inorganic chemicals listed above for shallow soil, vanadium is significantly higher than background (with more than 99% certainty), while arsenic and mercury are not significantly above background. TPH was identified in all seven samples analyzed at concentrations ranging from 87.5 to 3,000 mg/kg. The maximum concentration exceeds the NAVBASE soil AL of 100 mg/kg.

Groundwater

As shown in Table 6.2.15.5, the COPCs identified in shallow groundwater for this site based on first-quarter results are chloromethane and vinyl chloride, which were not detected during second-quarter sampling (Table 6.2.15.6).

6.2.15.3 Exposure Assessment

Exposure Setting

The exposure setting at AOC 666 is a UST (Facility NS-45) of unknown capacity, enclosed by creosote-treated railroad ties. The UST site is approximately 10 feet x 30 feet. The tank supplies No. 2 fuel oil to the adjacent heating plant (NS-44). The site was constructed in 1958 at a former airstrip.

Current base reuse plans call for continued commercial/industrial use of this site as a marine cargo terminal.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers as well as hypothetical future site residents. Because many traditional activities at NAVBASE have ceased or are expected to cease in the near future, current site workers were not specifically addressed in the formal assessment. Due to the lack of information regarding the specific functions that will be performed by future site workers, a standard default scenario was developed for these individuals. A similar approach was applied for future site residents.

Exposure Pathways

Exposure pathways for future site workers and site residents were based on an evaluation of the impacted media identified at AOC 666. Relative to the soil matrix, incidental ingestion and dermal contact were considered viable exposure pathways. Ingestion and inhalation of COPCs identified in shallow groundwater were assessed in this HHRA. Uniform exposure was assumed for all sample locations. Table 6.2.15.7 presents the exposure pathway selection process and justifies for each pathway evaluated.

Exposure Point Concentrations

At combined AOC 666, no more than 10 samples were collected from each potential exposure medium. As a result, the maximum concentration of each COPC identified in soil and groundwater was used as the EPC. The use of maximum concentrations does not account for variability in groundwater and soil conditions at AOC 666.

Quantification of Exposure

Tables 6.2.15.8 and 6.2.15.9 present the CDIs for the ingestion and dermal soil contact pathways. Table 6.2.15.10 presents the CDI for the ingestion groundwater pathway.

6.2.15.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 6.1.5 of this report. Table 6.2.15.11 summarizes toxicological risk information for the COPCs identified at AOC 666. Brief toxicological profiles for COPCs follow.

N-Nitroso-di-n-propylamine is an SVOC which is a USEPA B2 carcinogen in two species and a mutagen. As listed in IRIS (search date 7/95), the classification is based on increased tumor incidence at multiple sites in two rodent species and in monkeys to which the compound was administered by various routes. The respiratory system and liver were determined to be the primary sites for cancer caused by this compound. USEPA determined the oral SF to be 7.0 $(mg/kg\text{-}day)^{-1}$.

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al, 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on an NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingesting these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. As listed in IRIS (search date 9/1/95), the classification is based on sufficient evidence from human data. Increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.038 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

PCB Aroclors are groups of chlorinated hydrocarbons (such as ***Aroclor-1248, 1254, and 1260***) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme concentrations, rashes, chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified PCB Aroclors as group B2 carcinogens, primarily based on animal data. As listed in IRIS (search date 6/29/95), the classification is based on hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate yet suggestive evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. USEPA set 7.7 $(mg/kg\text{-}day)^{-1}$ as the SF_o for PCB Aroclors. Oral RfDs have been set for Aroclor-1016 (0.00007 mg/kg-day) and Aroclor-1254 (0.00002 mg/kg-day).

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1

Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the B2 classification is based on insufficient human data specifically linking BAP to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS (search date 6/28/95), the dibenzo(a,h)anthracene and benzo(b)fluoranthene B2 classification is based on no human data but sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. It also produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. It also mutates in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene***, ***acenaphthene***, ***acenaphthylene***, ***benzo(g,h,i)perylene***, and ***phenanthrene***. USEPA determined RfDs for only two of these compounds: pyrene's RfD_o of 0.03 mg/kg-day, is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

Mercury occurs in three forms: elemental, organic, and inorganic. The major source of this element is the degassing of the earth's crust. Target organs of inorganic mercury include the kidney, nervous system, fetus, and neonate. Mercury can be toxic to a fetus if the mother is exposed during pregnancy. This element is toxic to all cells in the body, it binds to enzymes in the cells and disrupts their function, usually causing the cell to become useless or die. Because this inorganic is concentrated in the kidney prior to excretion, the kidney is a major target organ for mercury ingestion. The primary target of mercury vapor is the brain. Some forms of mercury are drawn toward fats in the body (such as the nervous system), where the it changes into its toxic form. This causes the nervous disorder known as Minimata disease, overexposure to mercury through ingestion of contaminated fish. At Minimata, Japan, fish ingested inorganic mercury from an industrial discharge, and the inorganic form was metabolized to organic mercury (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA set mercury's RfD to 0.0003 mg/kg-day (inorganic form). Mercury is liquid at room temperature, and is poorly absorbed in this form if ingested. Typical daily exposure is less than 1 μg/L-day.

Vanadium is not readily absorbed through the skin or oral ingestion and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaassen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust, an exposure pathway not addressed in this risk assessment. Typical vitamin supplements contain approximately 0.010 mg in a daily dose. The RfD_o set by USEPA is 0.007 mg/kg-day.

Chloromethane is a colorless gas with an ethereal odor and sweet taste. It is slightly soluble in water and volatile. Acute poisoning is characterized by the narcotic effect. In addition, repeated exposure to low concentrations damages the CNS and, less frequently, the liver, kidneys, bone marrow, and cardiovascular system. Hemorrhages into the lungs and intestinal tract have also been reported. In exposures to high concentration, dizziness, drowsiness, uncoordination, confusion, nausea, vomiting, abdominal pains, hiccoughs, diplopia, and dimness of vision followed by delirium, convulsions, and coma have been reported and death may be immediate. Death may occur several days later from degenerative changes in the heart, liver, and especially the kidneys (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA has established an oral SF of 0.013 $(mg/kg\text{-}day)^{-1}$ and an inhalation SF of 0.0063 $(mg/kg\text{-}day)^{-1}$.

Vinyl chloride is a volatile organic that can cause Raynaud's Phenomenon, also known as white finger disease. It has been shown to cause angiosarcoma, a cancer, and has been associated with reproductive dysfunction in men and women. The primary target organs for noncarcinogenic effects are the liver, kidney, and nervous system. This compound inhibits one of the main metabolic pathways of the body (a group of enzymes), and can influence the toxicity of other compounds because of this effect (Klaassen et al., 1986; Dreisbach et al., 1987). Due to the carcinogenicity of this compound, USEPA classified vinyl chloride as a class A carcinogen and set the SF_i and SF_o to 0.3 and 1.9 $(mg/kg\text{-}day)^{-1}$, respectively.

6.2.15.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants, evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 6.2.15.12 and 6.2.15.13 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of site surface soil, and dermal contact with it.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 666 surface soil is 9E-5. The dermal pathway ILCR is 2E-5. BEQs, n-nitroso-di-n-propylamine, and arsenic were the primary contributors for both pathways. PCB Aroclor-1260 was also a primary contributor for the incidental ingestion pathway.

The computed HI for the adult resident was 0.2 for the soil ingestion pathway. The computed HI for the child ingestion pathway was 2. The primary contributors are arsenic (HQ_{child}-1.3) and vanadium (HQ_{child}-0.5). The dermal contact pathway HIs were 0.04 and 0.14 for the adult resident and the child resident, respectively.

Hypothetical Site Workers

Site worker ILCRs are 1E-5 and 8E-6 for the ingestion and dermal contact pathways. BAP and arsenic were the primary contributors for each pathway. The HIs for the hypothetical site worker ingestion and dermal pathways were estimated to be 0.07 and 0.03, respectively.

Although the frequency of detection is low for some COPCs, a formal hot spot approach was not used to estimate exposure. Arsenic was reported in five of seven surface soil samples analyzed, and would not be affected by a percent area adjustment. The Wilcoxon rank sum results for AOC 666 indicate that soil arsenic concentrations are not significantly above background; however, arsenic was included as a COPC because of concentrations exceeding the RBC.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under both residential and industrial scenarios. For these scenarios, the ingestion and inhalation exposure pathways were evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, which draws from the corresponding water-bearing zone, will be installed. HIs were not calculated for this exposure pathway because reference doses were not available for the groundwater COPCs. Tables 6.2.15.14 and 6.2.15.15 present the computed risks and/or HQs associated with the groundwater ingestion and inhalation pathways, respectively. Chloromethane and vinyl chloride, the COPCs identified in shallow groundwater, were detected exclusively in first-quarter samples.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 666 is 6E-5. The inhalation pathway ILCR is 1E-5. The primary contributor to risk for the groundwater pathway was vinyl chloride and chloromethane. The HIs for ingestion and inhalation pathways were below 0.01, and the contributor was chloromethane.

Hypothetical Site Workers

Site worker ILCRs are 1.5E-5 and 2.3E-6 for the ingestion and inhalation exposure pathways, respectively. The primary contributor to risk for the groundwater pathway was vinyl chloride. The HIs for ingestion and inhalation pathways were below 0.01, and the contributor was chloromethane.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 666 or other Zone H areas. In the absence of a completed exposure pathway, reported shallow groundwater contamination poses no threat to human health.

Vinyl chloride and chloromethane were reported in only one well during the first quarter of shallow groundwater monitoring. The presence of these COPCs should be confirmed by third- and fourth-quarter groundwater monitoring data. The concentration reported for vinyl chloride is approximately equal to the MCL of 0.002 mg/L.

COCs Identified

COCs at AOC 666 were identified based on cumulative (all pathway) risk and hazard projected for this site, as shown in Table 6.2.15.16. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or an HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is comparatively conservative as USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection algorithm more comprehensively evaluates chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

Surface Soil

Hypothetical Site Residents (Future Land Use)

PCB Aroclor-1260, BEQs, arsenic, n-nitroso-di-n-propylamine, and vanadium were identified as COCs for surface soil based on their contribution to risk/hazard.

Hypothetical Site Workers (current land use)

BEQs, arsenic, and n-nitroso-di-n-propylamine were identified as COCs for surface soil based on their contribution to site worker risk. No hazard-based COCs were identified for the site worker scenario.

Groundwater

Hypothetical Site Residents (Future Land Use)

The carcinogenic COCs identified in shallow groundwater are chloromethane and vinyl chloride based on their contribution to risk. No hazard-based COCs were identified for this pathway.

Hypothetical Site Workers (current land use)

The carcinogenic COC identified in shallow groundwater is vinyl chloride based on its contribution to risk. No hazard-based COCs were identified for this pathway.

The extent of the COCs identified in shallow groundwater is briefly discussed below. Residential RGOs were compared to each reported concentration for each COC identified above. RGOs are described in Section 6.2.15.8 of this HHRA. RGOs used for this comparison were calculated based on an ILCR of 1E-6 and/or an HQ of 1.0 (where applicable). Chloromethane and vinyl chloride were reported at concentrations in exceeding the corresponding RGOs at sample location 666GW001.

Consideration of third- and fourth-quarter results will confirm whether the presence of chloromethane and vinyl chloride are present in shallow groundwater. This review will facilitate responsible and sound risk management decisions.

6.2.15.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site groundwater, and approximately 100% of the site is currently a grassy area bounded by a gravel parking lot and a paved road. Site workers are exposed to surface soil when walking across the site, pumping fuel, or during maintenance activities. However, site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. Pumping fuel onsite 52 days per year would result in one-fifth the projected risk/hazard for site workers. If the exposure were adjusted to account for the percentage of time spent pumping fuel, CDI (and thus risk/hazard estimates) would be much less than that presented earlier.

Residential use of the site would not be expected, based on current uses and the nature of surrounding buildings. Current reuse plans call for continued commercial and/or industrial use of Zone H as a marine cargo terminal. If this area is used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at AOC 666 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone H. This system is to remain in operation under the current base reuse plan. As a result, shallow groundwater use would not be expected under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed.

Determination of Exposure Point Concentrations

The maximum reported concentrations of AOC 666 soil and groundwater COPCs were used as the respective EPCs for this site.

Frequency of Detection and Spatial Distribution

Of the COCs identified in this HHRA for AOC 666 surface soil, PCB Aroclor-1260 and n-nitroso-di-n-propylamine were detected in only one of seven samples analyzed. As previously discussed, the maximum reported concentration was used to calculate CDI for all COPCs in both soil and groundwater. Therefore, confidence in the EPCs calculated for the soil pathway is lower due to the relatively low frequency of detection of most COPCs. No one hot spot was identified for the group of COPCs. Arsenic, the primary contributor to the HI, was reported at two locations where the arsenic HQ would exceed 1.0: 666SB002 and 666SB004. The maximum concentrations were reported at 666SB004. Concentrations reported at the remaining sample locations would not exceed an HQ of 1.0. The estimated hazard is likely an overestimate.

PAHs such as BEQs are relatively widespread compounds found on or near creosote-coated wood, roadways, asphalt parking lots, and generally in high-traffic areas. Soil samples from this AOC were collected near a gravel parking lot, which is a potential source of PAHs and possibly other compounds. The estimated risk is likely an overestimate.

In shallow groundwater, significant uncertainty exists in the COPCs identified and their corresponding risk/hazard. Two monitoring wells were used to characterize shallow groundwater within AOC 666. Chloromethane and vinyl chloride were detected in one during the first quarter and were not detected in the second-quarter samples. The maximum concentration reported for vinyl chloride (0.0021 mg/L) is approximately equal to its MCL (0.002 mg/L). Third and fourth quarters of groundwater monitoring data should be used to confirm whether these COCs are present. Risk management decisions based on risk/hazard estimates for these compounds should be made subsequent to obtaining third- and fourth-quarter groundwater monitoring results.

Quantification of Risk/Hazard

As indicated above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

As a measure of variability, CT was analyzed for soil and groundwater. Exposure assumptions were modified to reflect the 50th percentile rather than the 95th, and EPCs were not modified. In accordance with *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure-Draft* (USEPA, 1993), the exposure duration of site residents were reduced from 30 to nine years, two years for child exposure and seven years for adult exposure. Exposure frequency was reduced from 350 to 234 days for site residents and from 250 to 219 days for site workers. The drinking water ingestion rate for an adult was reduced from 2 to 1.4 liters per day, and exposure to groundwater was reduced by 25% to account for other water sources. Soil ingestion rates for site residents were reduced by 50%, and dermal surface area was not modified. CDI, risk and hazard based on CT exposure assumptions are presented and discussed below.

Soil

Of the CPSSs eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs.

Beryllium and manganese concentrations exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding reference concentrations. Therefore, they were eliminated from formal assessment based on comparisons to the reference concentrations because they did not contribute to excess risk/hazard at the site.

Both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard. Arsenic, PCB Aroclor-1260, BEQs, and n-nitroso-di-n-propylamine, the primary contributors to soil risk, were not adjusted for the FI/FC. Arsenic was reported in five of seven samples and was not significantly above background concentrations (based on the Wilcoxon rank sum results for arsenic). The exposure estimates for these COPCs were based on the maximum reported concentrations, and variability was not addressed. If arsenic is determined to not be a concern at this site, at some point, the distribution of BEQs in surface soil should be considered and variability should also be addressed. The mean concentration of BEQs reported in AOC 666 surface soil (0.334 mg/kg) would result in ILCR of approximately 6E-6 for the cumulative soil resident (as opposed to 2E-5, which was based on the maximum reported concentration). A map was not produced for this site.

CDIs based on CT exposure assumptions are presented in Tables 6.2.15.17 and 6.2.15.18 for incidental ingestion of soil and dermal contact with soil, respectively. Risk and hazard based on CT are presented in Tables 6.2.15.19 and 6.2.15.20 for incidental ingestion of soil and dermal contact with soil.

Hypothetical Site Residents (Future Land Use)

ILCR estimated for the incidental ingestion pathway was 1E-5. Arsenic and BEQs were the primary contributors to ICLR. HIs estimated for this pathway were 0.1 and 1 for the adult and child scenarios, respectively, and arsenic and vanadium accounted for most of the hazard estimated for the ingestion exposure pathway.

ILCR estimated for the dermal contact pathway was 4E-6. BEQs, arsenic, and n-nitroso-di-n-propylamine were primary contributors to ICLR. HIs estimated for this pathway were 0.03 and 0.6 for the adult and child scenarios, respectively.

Hypothetical Site Workers (current land use)

ILCR estimated for the ingestion pathway was 2E-6 and the HI was estimated to be 0.06. Arsenic and BEQs were the primary contributors to ICLR. The dermal contact pathway ILCR was estimated to be 1E-6, and the HI was estimated to be 0.03. BEQs, arsenic, and n-nitroso-di-n-propylamine were primary contributors to ILCR. Arsenic and vanadium accounted for most of the hazard estimated for the ingestion exposure pathway.

Groundwater

Of the CPSSs eliminated from formal assessment, none was reported at concentrations within approximately 10% of the RBC, reducing the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs.

CDIs calculated based on CT exposure to shallow groundwater are presented in Table 6.2.15.21. Risk and hazard based on CT are presented in Tables 6.2.15.22 and 6.2.15.23 for ingestion and inhalation of COPCs identified in shallow groundwater.

Hypothetical Site Residents (Future Land Use)

ILCR estimated for the ingestion of shallow groundwater was 8E-6. The only contributor to ILCR was vinyl chloride. Vinyl chloride and chloromethane were also assessed for inhalation exposure and inhalation ILCR was estimated to be 1E-6. The hazard indices for ingestion and inhalation pathways were below 0.01.

Hypothetical Site Workers (Future Land Use)

The ingestion exposure pathway ILCR was estimated to be 2E-6 for the site worker exposure scenario. Vinyl chloride was the primary contributor for the ILCR estimate. The HI was not estimated for future site workers. Vinyl chloride and chloromethane were also assessed for the inhalation exposure pathway, and the site worker ILCR was estimated to be 3E-7. The HIs for ingestion and inhalation pathways were below 0.01.

6.2.15.7 Risk Summary

The risk and hazard posed by contaminants at AOC 666 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion and inhalation were evaluated for shallow groundwater based on first- and second-quarter groundwater monitoring data. Table 6.2.15.24 summarizes the risk for each pathway/receptor group evaluated for AOC 666.

6.2.15.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the residential lifetime weighted average and the adult site worker, as presented in Tables 6.2.15.25 and 6.2.15.26 for surface soil. Hazard-based RGOs were calculated based on either the hypothetical child resident or the adult site worker, as noted in the corresponding tables.

Groundwater

Groundwater RGOs based on site residents and site workers are presented in Tables 6.2.15.27 and 6.2.15.28, respectively.

Table 6.2.15.1
Methods Run at AOC 666
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
666	B001	S	S	S	Y					S	Y					
666	B002	S	S	S	Y					S	Y					
666	B003	B	B	B	Y	Y	Y	Y	A	B	B					
666	B004	S	S	S	Y					S	Y					
666	B005	S	S	S	Y					S	Y					
666	B006	S	S	S	Y					S	Y					
666	B007	S	S	S	Y					S	Y					
666	B02A													Y	Y	Y
666	B07A													Y	Y	Y

METHODS:

- Metal: TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
- VOA: Volatile Organics: Method 8240
- SVOA: Semi-volatile Organics: Method 8270
- Cn: Cyanide (Soil: Method 9010, Water: Method 9012)
- Hexac: Hexavalent Chromium: Method 7195
- Dioxin: Dioxins: Method 8290
- Oppe: Organophosphate Pesticides: Method 8140
- Herb: Chlorinated Herbicides: Method 8150
- Pest: Chlorinated Pesticides: Method 8080
- Tph: Total Petroleum Hydrocarbons: Method 418.1
- Tph GR: Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
- Tph DR: Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
- Wq I: Wet Chemistry I Parameters
- Wq II Wet Chemistry II Parameters
- Phys: Physical Chemistry Parameters

KEY:

- Y: Analyzed for standard list
- S: Analyzed for parameters on SW-846 list
- A: Analyzed for parameters on Appendix IX list
- B: Analyzed for parameters on both the SW-846 and Appendix IX lists

Blank value indicates this method of analysis was not performed

Table 6.2.15.2
Methods Run at AOC 666
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
666	W001	S	S	S	Y					S	Y					
666	W002	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.15.3
Methods Run at AOC 666
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
666	W001	S	S	S												
666	W002	S	S	S												

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.15.4
AOC 666
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/KG	1/ 7	330.00 - 4000.00	380.000 - 380.000	380.000	470000.0000			
Aluminum	MG/KG	7/ 7		705.000 - 6960.000	5025.000	7800.0000		25310.000	
Antimony	MG/KG	4/ 7	1.00 - 2.00	1.500 - 2.000	1.725	3.1000			
* Aroclor-1260	UG/KG	1/ 7	30.00 - 6200.00	88.400 - 88.400	88.400	83.0000	1		
* Arsenic	MG/KG	5/ 7	0.58 - 5.60	0.760 - 30.500	11.372	0.3700	5	14.810	2
Barium	MG/KG	5/ 7	7.70 - 10.90	3.400 - 30.400	12.920	550.0000		40.330	
Benzo(g,h,i)perylene	UG/KG	1/ 7	330.00 - 4000.00	166.000 - 166.000	166.000	310000.0000r			
* Benzo(a)pyrene Equivalents	UG/KG	7/ 7		123.616 - 1469.830	334.320	88.0000	7		
Benzo(a)anthracene	UG/KG	1/ 7	330.00 - 4000.00	481.000 - 481.000	481.000				
Benzo(b)fluoranthene	UG/KG	2/ 7	330.00 - 4000.00	181.000 - 2400.000	1290.500				
Chrysene	UG/KG	2/ 7	330.00 - 4000.00	133.000 - 1730.000	931.500				
Benzo(a)pyrene	UG/KG	2/ 7	330.00 - 4000.00	196.000 - 1180.000	688.000				
Beryllium	MG/KG	5/ 7	0.11 - 0.16	0.040 - 0.200	0.114	0.1500	2	1.470	
Butylbenzylphthalate	UG/KG	1/ 7	330.00 - 4000.00	57.800 - 57.800	57.800	1600000.0000			
Cadmium	MG/KG	3/ 7	0.12 - 0.94	0.400 - 0.710	0.506	3.9000		1.050	
Calcium	MG/KG	7/ 7		938.000 - 56900.000	11111.142				
gamma-Chlordane	UG/KG	1/ 7	3.00 - 300.00	8.900 - 8.900	8.900	470.0000			
4-Chloro-3-methylphenol	UG/KG	1/ 7	330.00 - 4000.00	380.000 - 380.000	380.000				
2-Chlorophenol	UG/KG	1/ 7	330.00 - 4000.00	3800.000 - 3800.000	3800.000	39000.0000			
Chromium	MG/KG	5/ 7	2.80 - 14.40	5.200 - 35.100	14.610	39.0000		85.650	
Cobalt	MG/KG	5/ 7	0.81 - 2.00	0.520 - 2.200	1.184	470.0000		5.860	
Copper	MG/KG	5/ 7	3.30 - 4.40	3.700 - 138.000	51.560	290.0000		27.600	3
Di-n-butylphthalate	UG/KG	4/ 7	380.00 - 4000.00	60.500 - 567.000	294.600	780000.0000			
1,4-Dichlorobenzene	UG/KG	1/ 7	330.00 - 4000.00	380.000 - 380.000	380.000	27000.0000			
2,4-Dinitrotoluene	UG/KG	1/ 7	330.00 - 4000.00	380.000 - 380.000	380.000	16000.0000			
Dioxin (TCDD TEQ)	PG/G	1/ 1		5.420 - 5.420	5.420	1000.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	1/ 7	330.00 - 4000.00	116.000 - 116.000	116.000	46000.0000			
Fluoranthene	UG/KG	2/ 7	330.00 - 4000.00	175.000 - 5690.000	2932.500	310000.0000			
Iron	MG/KG	7/ 7		603.000 - 6240.000	3030.428			30910.000	
Lead	MG/KG	5/ 7	14.80 - 40.60	3.200 - 118.000	47.400	400.0000j		118.000	1
Magnesium	MG/KG	6/ 7	81.40 - 81.40	145.000 - 1910.000	597.333			9592.000	
Manganese	MG/KG	5/ 7	6.50 - 28.80	3.300 - 78.200	28.880	39.0000	1	636.400	
* Mercury	MG/KG	5/ 7	0.02 - 0.05	0.030 - 2.300	0.510	2.3000	1	0.490	1
Nickel	MG/KG	5/ 7	13.60 - 137.00	3.800 - 39.300	23.340	160.0000		33.380	2

Table 6.2.15.4
AOC 666
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
4-Nitrophenol	UG/KG	1/ 7	1600.00 -	19000.00	380.000 -	380.000	380.000	480000.0000			
* N-Nitroso-di-n-propylamine	UG/KG	1/ 7	330.00 -	4000.00	380.000 -	380.000	380.000	91.0000	1		
Pentachlorophenol	UG/KG	1/ 7	730.00 -	19000.00	380.000 -	380.000	380.000	5300.0000			
Phenanthrene	UG/KG	2/ 7	330.00 -	4000.00	44.800 -	1080.000	562.400	310000.0000k			
Phenol	UG/KG	1/ 7	330.00 -	4000.00	380.000 -	380.000	380.000	4700000.0000			
Potassium	MG/KG	5/ 7	105.00 -	297.00	105.000 -	286.000	193.000				
Pyrene	UG/KG	3/ 7	330.00 -	4000.00	147.000 -	4320.000	1615.666	230000.0000			
Selenium	MG/KG	3/ 7	0.24 -	0.31	0.300 -	0.620	0.456	39.0000		2.000	
Sodium	MG/KG	3/ 7	12.80 -	74.40	41.700 -	275.000	121.200				
* Petroleum Hydrocarbons, TPH	MG/KG	7/ 7			87.500 -	3000.000	839.642	10.0000	7		
Toluene	UG/KG	1/ 7	5.00 -	14.00	14.000 -	14.000	14.000	1600000.0000			
1,2,4-Trichlorobenzene	UG/KG	1/ 7	330.00 -	4000.00	380.000 -	380.000	380.000	78000.0000			
* Vanadium	MG/KG	7/ 7			12.000 -	275.000	108.114	55.0000	4	77.380	4
Zinc	MG/KG	6/ 7	20.50 -	20.50	4.600 -	285.000	123.133	2300.0000		214.300	2

Notes:

*	Retained as a chemical of potential concern
a	USEPA Region III Residential Risk-Based Screening Value, March 1994
f	Fluoranthene used as surrogate
j	Based on proposed action level for soil and treatment technique action level for water
k	Fluoranthene used as surrogate

Table 6.2.15.5
AOC 666
Shallow Groundwater, Sampling Round 01

	Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds		Range of Detected Concentrations		Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
	Acenaphthene	UG/L	1/ 2	11.00 -	11.00	14.000 -	14.000	14.000	220.0000			
	Barium	UG/L	1/ 2	0.90 -	0.90	53.600 -	53.600	53.600	260.0000		323.000	
	Calcium	UG/L	2/ 2			87900.000 -	111000.000	99450.000				
*	Chloromethane	UG/L	1/ 2	10.00 -	10.00	6.000 -	6.000	6.000	1.4000	1		
	Iron	UG/L	2/ 2			259.000 -	1600.000	929.500				
	Magnesium	UG/L	2/ 2			33700.000 -	95700.000	64700.000				
	Manganese	UG/L	2/ 2			43.400 -	102.000	72.700	18.0000	2	3391.000	
	Potassium	UG/L	2/ 2			17600.000 -	47500.000	32550.000				
	Sodium	UG/L	2/ 2			88900.000 -	1010000.000	549450.000				
	Vanadium	UG/L	2/ 2			4.500 -	6.700	5.600	26.0000			
*	Vinyl chloride	UG/L	1/ 2	10.00 -	10.00	2.100 -	2.100	2.100	0.0190	1		

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.15.6
AOC 666
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acenaphthene	UG/L	1/ 2	11.00 - 11.00	8.850 - 8.850	8.850	220.0000			
Barium	UG/L	2/ 2		4.200 - 40.100	22.150	260.0000		323.000	
Calcium	UG/L	2/ 2		67100.000 - 83200.000	75150.000				
Iron	UG/L	2/ 2		122.350 - 1100.000	611.175				
Magnesium	UG/L	2/ 2		33650.000 - 91900.000	62775.000				
Manganese	UG/L	2/ 2		30.300 - 78.400	54.350	18.0000	2	3391.000	
Nickel	UG/L	1/ 2	5.50 - 5.50	21.800 - 21.800	21.800	73.0000			
Potassium	UG/L	2/ 2		15550.000 - 42800.000	29175.000				
Sodium	UG/L	2/ 2		87400.000 - 1120000.000	603700.000				
Vanadium	UG/L	2/ 2		4.500 - 8.400	6.450	26.0000			
Zinc	UG/L	1/ 2	5.80 - 5.80	9.600 - 9.600	9.600	1100.0000			

Notes:

- • Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.15.7
Exposure Pathways Summary — AOC 666
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 666.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 666.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	CPSSs were greater than RBC and Reference concentrations.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	VOCs were identified at this site based on the screening comparisons used to develop the list of COPCs.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.

Table 6.2.15.7
Exposure Pathways Summary — AOC 666
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.15.8
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Arsenic	NA	30.5	4.18E-05	3.90E-04	4.77E-05	1.49E-05	5.33E-06
Aroclor-1260	NA	0.088	1.21E-07	1.13E-06	1.38E-07	4.32E-08	1.54E-08
Benzo(a)pyrene Equivalents	1	1.47	2.01E-06	1.88E-05	2.30E-06	7.19E-07	2.57E-07
Mercury	NA	2.3	3.15E-06	2.94E-05	3.60E-06	1.13E-06	4.02E-07
N-Nitroso-di-n-propylamine	NA	0.380	5.21E-07	4.86E-06	5.95E-07	1.86E-07	6.64E-08
Vanadium	NA	275	3.77E-04	3.52E-03	4.31E-04	1.35E-04	4.81E-05

NOTES:

TEF	toxic equivalency factor relative to Benzo(a)pyrene
lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
-	exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.15.9
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Arsenic	NA	30.50	0.001	1.71E-06	5.65E-06	1.07E-06	1.22E-06	4.37E-07
Aroclor-1260	NA	0.09	0.01	4.96E-08	1.64E-07	3.11E-08	3.55E-08	1.27E-08
Benzo(a)pyrene Equivalents	1	1.47	0.01	8.26E-07	2.72E-06	5.17E-07	5.90E-07	2.11E-07
Mercury	NA	2.30	0.001	1.29E-07	4.26E-07	8.08E-08	9.23E-08	3.30E-08
N-Nitroso-di-n-propylamine	NA	0.38	0.01	2.13E-07	7.04E-07	1.34E-07	1.52E-07	5.44E-08
Vanadium	NA	275.00	0.001	1.54E-05	5.10E-05	9.67E-06	1.10E-05	3.94E-06

NOTES:

TEF Toxic Equivalency Factor relative to benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.15.10
Chronic Daily Intakes (CDI)
Ingestion/Inhalation of Chemicals Reported in Shallow Groundwater
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Vinyl chloride	0.0021	5.75E-05	1.34E-04	3.16E-05	2.14E-05	7.63E-06
Chloromethane	0.006	1.64E-04	3.84E-04	9.04E-05	6.11E-05	2.18E-05

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

ble 6.2.15.11 - AOC 666
xicological Database Information
Chemicals of Potential Concern
VBASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

emical	Oral Reference Dose (mg/kg/day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation
senic	0.0003	a	M	hyperpigmentation	3	ND			ND
B Aroclor-1260	ND				ND	ND			ND
yl chloride	ND				ND	ND			ND
nzo(a)pyrene Equivalents	ND				ND	ND			ND
loromethane*	0.257		H	hepatotoxicity	300	0.257	H	hepatotoxicity	ND
rcury	0.0003	a	M	hand tremor and memory distur	30	ND			ND
Nitroso-di-n-propylamine	ND				ND	ND			ND
nadium	0.007	a		unclear	100	ND			ND

NOTES:

a Integrated Risk Information System (IRIS)
b Health Effects Assessment Summary Tables (HEAST)
g Provided by USEPA Region IV
* Provisional subchronic RfDi=2.57; for chronic (oral & inhale) a UF of 10 was applied--0.257
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

able 6.2.15.11 - AOC 666
oxicological Database Information
or Chemicals of Potential Concern
AVBASE Charleston, Zone H

Carcinogenic Toxicity Data

hemical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
rsenic	1.5	a	15.1	a	A	various
CB Aroclor-1260	7.7		ND		B2	hepatocellular carcinoma
inyl chloride	1.9	b	0.3	b	A	hepatocellular carcinoma
enzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen
hloromethane*	0.012	b	0.0063	b	C	kidney tumors
lercury	ND		ND		D	
-Nitroso-di-n-propylamine	7	a			B2	various
anadium	ND		ND		D	

Table 6.2.15.12
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Arsenic	0.0003	1.5	0.14	1.3	7.2E-05	0.050	8.0E-06
Aroclor-1260	NA	7.7	ND	ND	1.1E-06	ND	1.2E-07
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	1.7E-05	ND	1.9E-06
Mercury	0.0003	NA	0.0105	0.098	ND	0.00375	ND
N-Nitroso-di-n-propylamine	NA	7	ND	ND	4.2E-06	ND	4.6E-07
Vanadium	0.007	NA	0.054	0.50	ND	0.019	ND
SUM Hazard Index/ILCR			0.2	2	9E-05	0.07	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.15.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Arsenic	0.2	6E-05	7.5	0.0286	0.094	8.0E-06	0.0204	3.3E-06
Aroclor-1260	0.5	NA	15.4	ND	ND	4.8E-07	ND	2.0E-07
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	7.5E-06	ND	3.1E-06
Mercury	0.2	6E-05	NA	0.00215	0.00711	ND	0.001538	ND
N-Nitroso-di-n-propylamine	0.5	NA	14	ND		1.9E-06	ND	7.6E-07
Vanadium	0.2	0.0014	NA	0.0110	0.036	ND	0.0079	ND
SUM Hazard Index/ILCR				0.042	0.14	2E-05	0.030	7E-06

Table 6.2.15.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Vinyl chloride	NA	1.9	ND	ND	6.0E-05	ND	1.5E-05
Chloromethane	NA	0.013	ND	ND	1.2E-06	ND	2.8E-07
SUM Hazard Index/ILCR			ND	ND	6.1E-05	ND	1.5E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.15.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Vinyl chloride	NA	0.3	ND	ND	9.5E-06	ND	2.3E-06
Chloromethane	NA	0.0063	ND	ND	5.7E-07	ND	1.4E-07
SUM Hazard Index/ILCR			ND	ND	1.0E-05	ND	2.4E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

ıle 6.2.15.16
nmary of Risk and Hazard-Based COCs for AOC 666
/al Base Charleston Zone H
arleston, South Carolina

dium/Pathway	Chemical	Potential Future Resident Adult Hazard Quotient	Potential Future Resident Child Hazard Quotient	Potential Future Resident lwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs
l Incidental Ingestion	Arsenic	0.14	1.3	7.2E-05	0.05	8.0E-06	1 2 4
	Aroclor-1260	NA	NA	1.1E-06	NA	1.2E-07	2
	Benzo(a)pyrene Equivalents	NA	NA	1.7E-05	NA	1.9E-06	2 4
	Mercury	0.0105	0.098	NA	0.00375	NA	
	N-Nitroso-di-n-propylamine	NA	NA	4.2E-06	NA	4.6E-07	2
	Vanadium	0.054	0.5	NA	0.019	NA	1
l Incidental Ingestion Pathway Total		0.205	1.90	9E-05	0.073	1E-05	
l Dermal Contact Pathway	Arsenic	0.0286	0.094	8.0E-06	0.0204	3.3E-06	2 4
	Aroclor-1260	NA	NA	4.6E-07	NA	2.0E-07	
	Benzo(a)pyrene Equivalents	NA	NA	7.5E-06	NA	3.1E-06	2 4
	Mercury	0.00215	0.00711	NA	0.001538	NA	
	N-Nitroso-di-n-propylamine	NA		1.9E-06	NA	7.6E-07	2
	Vanadium	0.011	0.025	NA	0.0079	NA	
l Dermal Contact Pathway Total		0.042	0.13	2E-05	0.030	7E-06	
allow Groundwater Ingestion	Chloromethane	0.0006	0.001	1.2E-06	0.0002	2.8E-07	2
Pathway	Vinyl Chloride	NA	NA	6.0E-05	NA	1.5E-05	2 4
allow Groundwater Ingestion Pathway Total		0.0006	0.001	6E-05	0.0002	2E-05	
allow Groundwater Inhalation	Chloromethane	0.0006	0.001	5.7E-07	0.0002	1.4E-07	
Pathway	Vinyl Chloride	NA	NA	9.5E-06	NA	2.3E-07	2
allow Groundwater Inhalation Pathway Total		0.0006	0.001	1E-05	0.0002	4E-07	
Pathways Cumulative Total Risk/Hazard w/Shallow GW		0.2	2.0	2E-04	0.1	3E-05	

TES:
indicates the individual HQ was less than 0.1 and/or the ILCR was less than 1E-6.
.01 indicates the total hazard index for the pathway was less than 0.01.
Chemical is a COC by virtue of projected child resident non-carcinogenic hazard.
Chemical is a COC by virtue of projected future resident lifetime weighted average carcinogenic risk.
Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
Chemical is a COC by virtue of projected site worker carcinogenic risk.

Table 6.2.15.17
Central Tendancy Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Arsenic	NA	30.5	1.40E-05	1.30E-04	5.12E-06	1.31E-05	9.34E-07
Aroclor-1260	NA	0.1	4.05E-08	3.78E-07	1.48E-08	3.79E-08	2.71E-09
Benzo(a)pyrene Equivalents	1	1.5	6.73E-07	6.28E-06	2.47E-07	6.30E-07	4.50E-08
Mercury	NA	2.3	1.05E-06	9.83E-06	3.86E-07	9.86E-07	7.04E-08
N-Nitroso-di-n-propylamine	NA	0.4	1.74E-07	1.62E-06	6.38E-08	1.63E-07	1.16E-08
Vanadium	NA	275.0	1.26E-04	1.18E-03	4.62E-05	1.18E-04	8.42E-06

NOTES:

TEF	toxic equivalency factor relative to Benzo(a)pyrene
lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
-	exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.15.18
Central Tendancy Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Arsenic	NA	30.50	0.001	1.15E-06	2.61E-06	2.23E-07	1.07E-06	7.66E-08
Aroclor-1260	NA	0.09	0.01	3.32E-08	7.56E-08	6.45E-09	3.11E-08	2.22E-09
Benzo(a)pyrene Equivalents	1	1.47	0.01	5.52E-07	1.26E-06	1.07E-07	5.17E-07	3.69E-08
Mercury	NA	2.30	0.001	8.64E-08	1.97E-07	1.68E-08	8.08E-08	5.77E-09
N-Nitroso-di-n-propylamine	NA	0.38	0.01	1.43E-07	3.25E-07	2.77E-08	1.34E-07	9.54E-09
Vanadium	NA	275.00	0.001	1.03E-05	2.35E-05	2.01E-06	9.66E-06	6.90E-07

NOTES:

TEF Toxic Equivalency Factor relative to benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
- exposure point concentrations for PAHs were adjusted to equivalent concentrations of Benzo(a)pyrene by their corresponding TEF

Table 6.2.15.19
Central Tendancy Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Arsenic	0.0003	1.5	0.05	0.4	7.7E-06	0.044	1.4E-06
Aroclor-1260	NA	7.7	ND	ND	1.1E-07	ND	2.1E-08
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	1.8E-06	ND	3.3E-07
Mercury	0.0003	NA	0.0035	0.033	ND	0.00329	ND
N-Nitroso-di-n-propylamine	NA	7	ND	ND	4.5E-07	ND	8.1E-08
Vanadium	0.007	NA	0.018	0.17	ND	0.017	ND
SUM Hazard Index/ILCR			0.1	1	1E-05	0.06	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.15.20
Central Tendancy Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Arsenic	0.2	6E-05	8.75	0.0191	0.043	1.9E-06	0.0179	6.7E-07
Aroclor-1260	0.5	NA	15.4	ND	ND	9.9E-08	ND	3.4E-08
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.6E-06	ND	5.4E-07
Mercury	0.2	6E-05	NA	0.00144	0.00328	ND	0.001347	ND
N-Nitroso-di-n-propylamine	0.5	NA	14	ND		3.9E-07	ND	1.3E-07
Vanadium	0.2	0.0014	NA	0.0074	0.017	ND	0.0069	ND
SUM Hazard Index/ILCR				0.028	0.06	4E-06	0.026	1E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.15.21
Central Tendency Chronic Daily Intakes (CDI)
Ingestion of Shallow Groundwater
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Adjusted Exposure Point Concentration (mg/liter)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Future Worker adult H-CDI (mg/kg-day)	Potential Future Worker adult C-CDI (mg/kg-day)
Vinyl chloride	0.0021	2.02E-05	6.73E-05	3.89E-06	1.35E-05	9.64E-07
Chloromethane	0.006	5.77E-05	1.92E-04	1.11E-05	3.86E-05	2.76E-06

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 6.2.15.22
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Vinyl chloride	NA	1.9	ND	ND	7.4E-06	ND	1.8E-06
Chloromethane	0.257	0.013	0.0002	0.0007	1.4E-07	0.0002	3.6E-08
SUM Hazard Index/ILCR			0.0002	0.0007	8E-06	0.0002	2E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
The provisional subchronic inhalation RfD for chloromethane was applied as a surrogate value for oral RfD.
An uncertainty factor of 10 was applied to account for acute to chronic exposure.

Table 6.2.15.23
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants Volatilized from Shallow Groundwater
AOC 666
Naval Base Charleston
Charleston, SC

Chemical	Inhal RfD Used (mg/kg-day)	Inhal SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Future Worker adult Hazard Quotient	Potential Future Worker adult ILCR
Vinyl chloride	NA	0.3	ND	ND	1.2E-06	ND	2.9E-07
Chloromethane	0.257	0.0063	0.0002	0.0007	7.0E-08	0.0002	1.7E-08
SUM Hazard Index/ILCR			0.0002	0.0007	1E-06	0.0002	3E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
The provisional subchronic inhalation RfD for chloromethane was applied as a surrogate value for chronic inhalation RfD.
An uncertainty factor of 10 was applied to account for acute to chronic exposure.

Table 6.2.15.24
Summary of Risk and Hazard for AOC 666
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.205	1.9	9E-05	0.073	1E-05
	Dermal Contact	0.042	0.13	2E-05	0.030	7E-06
Shallow Groundwater	Ingestion	ND	ND	6E-05	ND	2E-05
	Inhalation	ND	ND	1E-05	ND	4E-07
Sum of All Pathways		0.2	2.0	2E-04	0.1	4E-05

Notes:
ND indicates not determined due to lack of available risk information
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 6.2.15.25
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 666 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjusted EPC mg/kg	**Hazard-Based Remedial Goal Options** 0.1 mg/kg	1.0 mg/kg	3 mg/kg	**Risk-Based Remedial Goal Options** 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Arsenic	1.5	0.0003	30.5	2	22	66	0.383	3.83	38.3	14.8
Aroclor-1260	7.7	NA	0.0884	ND	ND	ND	0.057	0.57	5.7	ND
Benzo(a)pyrene Equivalents	7.3	NA	1.46983	ND	ND	ND	0.060	0.60	6.0	ND
N-Nitroso-di-n-propylamine	7	NA	2.3	ND	ND	ND	0.381	3.81	38.1	ND
Vanadium	NA	0.007	275	51	510	1531	ND	ND	ND	77.4

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.15.26
Worker-Based Remedial Goal Options
Naval Base Charleston, AOC 666 Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Unadjusted EPC mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Arsenic	1.5	30.5	2.7	27	271	ND
Aroclor-1260	7.7	0.0884	0.28	2.8	28	ND
Benzo(a)pyrene Equivalents	7.3	1.46983	0.30	3.0	30	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

Table 6.2.15.27
Residential-Based Remedial Goal Options
Naval Base Charleston, AOC 666 Shallow Groundwater
Charleston, South Carolina

	Slope	Reference	Unadjuste	Hazard-Based Remedial Goal Options			Risk-Based Remedial Goal Options				Background
	Factor	Dose	EPC	0.1	1.0	10	1E-06	1E-05	1E-04	MCL	Concentration
Chemical	(mg/kg-day)-1	(mg/kg-day)	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Vinyl chloride	1.9	NA	0.0021	ND	ND	ND	0.00003	0.0003	0.003	0.005	ND
Chloromethane	0.013	NA	0.006	ND	ND	ND	0.003	0.03	0.3	NA	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

ıle 6.2.15.28
rker-Based Remedial Goal Options
/al Base Charleston, AOC 666 Shallow Groundwater
arleston, South Carolina

emical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Unadjuste EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	10 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
yl chloride	1.9	NA	0.0021	ND	ND	ND	0.0001	0.001	0.01	0.005	ND
loromethane	0.013	NA	0.006	ND	ND	ND	0.01	0.1	1	NA	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

6.2.16 Baseline Risk Assessment for AOC 667 and SWMU 138

6.2.16.1 Site Background and Investigative Approach

AOC 667 and SWMU 138 were investigated to assess soil and groundwater potentially affected by site activities. These sites were combined for investigation because of their proximity. AOC 667 encompasses a vehicle maintenance area with an oil-water separator. SWMU 138 is an SAA used to temporarily store hazardous waste in 55-gallon drums. Full drums are immediately transferred to a permitted hazardous waste storage facility. Seven surface soil samples (four at AOC 667 and three at SWMU 138) were collected. Table 6.2.16.1 lists each surface soil sample designation and analytical methods used. Groundwater samples were collected from two shallow monitoring wells and analyzed for a similar list of parameters. First- and second-quarter groundwater data were used as the basis for this HHRA.

6.2.16.2 COPC Identification

Soil

Surface soil data and screening values used in the screening comparison for AOC 667 and SWMU 138 soil are summarized in Table 6.2.16.4. As shown in the table, cPAHs (as BEQs) were the only identified soil COPCs. No additional COPCs were identified from the Wilcoxon rank sum test background comparisons of inorganic CPSSs exceeding their corresponding risk-based screening values. Therefore, surface soil was formally assessed considering BEQs. TPH was identified in both surface soil samples analyzed at concentrations ranging between 200 and 1,800 mg/kg. These concentrations exceed the NAVBASE soil AL level of 100 mg/kg.

Groundwater

Shallow groundwater data and screening values used in the screening comparisons for AOC 667 and SWMU 138 groundwater are summarized in Tables 6.2.16.5 and 6.2.16.6 for first- and second-quarter results, respectively. No groundwater COPCs were identified based on first- or second-quarter sampling results. No additional COPCs were identified from Wilcoxon rank sum test background comparisons of inorganic CPSSs exceeding their corresponding risk-based screening values.

6.2.16.3 Exposure Assessment

Exposure Setting

The exposure setting at combined AOC 667 and SWMU 138 is currently an automobile, truck and heavy-equipment maintenance facility and hazardous waste SAA. AOC 667 is a two-story brick building (Building 1776) and the area immediately around it, including a 550-gallon portable storage tank for waste oil and an oil-water separator. Numerous oil stains suggest past surface releases.

SWMU 138 is an SAA within 50 feet of the maintenance facility. The SAA stores hazardous wastes in 55-gallon drums which are immediately transferred to a permitted hazardous waste storage facility when full.

These sites are to remain commercial/industrial. AOC 667 and SWMU 138 are an area proposed to become an intermodal railyard and marine industrial park under current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations include current and future site workers as well as hypothetical future site residents. Because many traditional activities at NAVBASE have ceased or are expected to cease in the near future, current site workers were not specifically addressed in the formal assessment. Due to the lack of specific knowledge regarding the functions that will be performed by future site workers, a standard default scenario was developed for these individuals. A similar approach was applied for future site residents.

Exposure Pathways

Exposure pathways for future site workers and site residents were formulated based on an evaluation of the impacted media identified at AOC 667 and SWMU 138. Relative to the soil matrix, incidental ingestion and dermal contact were considered as viable exposure pathways.

Groundwater exposure pathways were not considered because no COPCs were identified. Uniform exposure was assumed for all sample locations. Table 6.2.16.7 presents the exposure pathway selection process and justifies for each pathway evaluated.

Exposure Point Concentrations

At AOC 667 and SWMU 138, fewer than 10 samples were collected from each potential exposure medium. As a result, the maximum concentration of each COPC identified in soil was used as the EPC. BEQs were detected in only one of seven surface soil samples collected (138SB003) at a concentration of 0.174 mg/kg. This sample was collected directly beneath an asphalt parking lot. Samples from around 138SB003 did not contain detectable concentrations of these COPCs. As a result, it was considered appropriate to derive an FI/FC accounting for the limited areal extent of the in surface soil contaminants. This factor was conservatively estimated to be 0.2, indicating that the maximum concentrations reported were representative of soil quality of 20% of the potential exposure area. This factor was used to adjust the EPC for these COPCs.

Quantification of Exposure

Soil

Tables 6.2.16.8 and 6.2.16.9 present the CDIs for the ingestion and dermal contact pathways, respectively.

6.2.16.4 Toxicity Assessment

A reference dose was not available for BEQs. Because all cPAHs were converted and combined in the form of BEQs, the BAP SF_o of 7.3 $(mg/kg\text{-}day)^{-1}$ was applied. A brief toxicological profile for cPAHs follows.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well-established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS (search date 6/28/95), the B2 classification is based on insufficient human data specifically linking BAP to a carcinogenic effect. However, multiple animal studies in many species demonstrate BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question; the USEPA classification, and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per (mg/kg-day). The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is based on no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous, or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene***, ***acenaphthene***, ***acenaphthylene***, ***benzo(g,h,i)perylene***, and ***phenanthrene***. USEPA determined RfDs for only two of these compounds: pyrene's RfD_o of 0.03 mg/kg-day, is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

6.2.16.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were considered. For noncarcinogenic chemicals evaluated for future site residents, hazard quotients were computed separately to address children and adults. Tables 6.2.16.10 and 6.2.16.11 present the computed carcinogenic risk and noncarcinogenic HQs associated with the incidental ingestion and dermal contact with surface soil, respectively.

Future Site Residents

The projected ingestion related ILCR from surface soil was 4E-7, and the dermal pathway risk was 2E-7. BEQs were the only contributors for both pathways. No reference dose is available for BAP; thus, no HQs were computed.

Future Site Workers

The projected ingestion related ILCR from surface soil was 4E-8, and the dermal pathway risk was 7E-8. BEQs were the only contributors for both pathways. No reference dose is available for BAP; thus, no HQs were computed.

Because site worker risk projections did not exceed the most conservative 1E-6 point of departure assuming that all surface soil was accessible for contact exposure the influences of site features were not formally assessed. It should be noted, however, that 75% to 80% of the surface area at SWMU 138/AOC 667 is paved, precluding exposure to underlying soil if features remain intact.

COCs Identified

COCs were identified based on soil pathway risk and hazard projected for the site. BEQs were the only COCs in AOC 667 and SWMU 138. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or an HI above 1.0, if its individual ILCR exceeds 1E-6 or its HQ exceeds 0.1. For carcinogens, this approach is comparatively conservative because USEPA Region IV recommends a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) as the trigger for establishing COCs. The COC selection method algorithm more comprehensively evaluates chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process.

Surface Soil

Hypothetical Site Residents

No COCs were identified for this scenario based on the sum ILCR and HI.

Hypothetical Site Workers

No COCs were identified for this scenario based on the sum ILCR and HI.

6.2.16.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Under current site use conditions, workers are infrequently exposed to surface soil when walking across the site, using the buildings and parking lot, or mowing the grass. In addition, approximately 75% to 80% of the surface area is asphalt pavement. Site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year as assumed in the exposure assessment. In fact, if site features are maintained under the reuse plan, the asphalt parking surface will prevent onsite worker exposure to surface soil.

Residential use of the site would not be expected, based on current uses and the nature of surrounding buildings. Current plans call for continued use as nonresidential maintenance building, parking lot, and storage sheds. If this area was used as a residential site, the buildings would be demolished, and the surface soil conditions would likely change. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

Because there were fewer than 10 surface soil samples, all EPCs used for this site are the maximum concentrations reported for respective COPCs. The surface soil EPCs were modified (where appropriate) to account for the reasonable FI/FC from the contaminated source. Risk values for shallow groundwater that are based on maximum concentrations are likely to be overestimates.

Frequency of Detection and Spatial Distribution

BEQs were detected in only one of seven soil samples (sample 138SB003). This limited areal extent was used to derive the FI/FC factor discussed in above. The only BEQ hits were J-qualified; therefore, confidence in the quantitation is relatively low.

Elevated TPH results (200 to 1800 mg/kg) were reported in soil onsite. No groundwater sample contained detectable concentrations of TPH, indicating that the shallow aquifer is sufficiently protected under current conditions with respect to soil-to-groundwater cross-media transport of TPH constituents. These TPH concentrations exceed the NAVBASE soil AL 100 mg/kg.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment because they did not exceed the corresponding RBCs, none was reported at a concentration within 10% of its RBC. This reduces the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of arsenic, beryllium, and chromium exceeded their corresponding RBCs, but maximum concentrations of these elements did not exceed the corresponding reference concentrations. They were eliminated from formal assessment based on comparisons to the reference concentrations because they did not contribute to excess risk/hazard at the site.

The sample in which BEQs were detected was from beneath an asphalt covered lot. BAP and other cPAHs are constituents of asphalt and their presence is not necessarily attributable to past or current site operation.

Both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard. A map was not produced for this site.

The CT assumption for residential exposure duration is nine years compared to the 30-year assumption for RME. If all other exposure assumptions remain fixed, application of the CT exposure duration would result in risk projections 66% below the RME. At CT, the surface soil-related risk (incidental ingestion and dermal contact) would fall well below the 1E-6 point of departure.

Groundwater

No COPCs were identified for this exposure pathway on the screening comparisons described in Section 6.1.3.4 of this report. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its corresponding RBC, reducing the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs.

6.2.16.7 Risk Summary

The risk and hazard posed by contaminants at AOC 667 and SWMU 138 were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 6.2.16.12 summarizes risk for the combined incidental ingestion and dermal pathways for AOC 667 and SWMU 138.

6.2.16.8 Remedial Goal Options

Soil

No RGO were calculated because no soil pathway COCs were identified.

Table 6.2.16.1
Methods Run at SWMU 667 (includes SWMU 138)
Surface Soil

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
138	B001	S	S	S	Y					S						
138	B002	B	B	B	Y	Y	Y	Y	A	B	A					
138	B003	S	S	S	Y					S						
667	B001	S	S	S	Y					S						
667	B002	B	B	B	Y	Y	Y	Y	A	B	A					
667	B003	S	S	S	Y					S						
667	B004	S	S	S	Y					S						

METHODS:

- Metal: TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
- VOA: Volatile Organics: Method 8240
- SVOA: Semi-volatile Organics: Method 8270
- Cn: Cyanide (Soil: Method 9010, Water: Method 9012)
- Hexac: Hexavalent Chromium: Method 7195
- Dioxin: Dioxins: Method 8290
- Oppe: Organophosphate Pesticides: Method 8140
- Herb: Chlorinated Herbicides: Method 8150
- Pest: Chlorinated Pesticides: Method 8080
- Tph: Total Petroleum Hydrocarbons: Method 418.1
- Tph GR: Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
- Tph DR: Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
- Wq I: Wet Chemistry I Parameters
- Wq II Wet Chemistry II Parameters
- Phys: Physical Chemistry Parameters

KEY:

- Y: Analyzed for standard list
- S: Analyzed for parameters on SW-846 list
- A: Analyzed for parameters on Appendix IX list
- B: Analyzed for parameters on both the SW-846 and Appendix IX lists

Blank value indicates this method of analysis was not performed

Table 6.2.16.2
Methods Run at SWMU 667 (Includes SWMU 138)
Shallow Groundwater, Sampling Round 01

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
667	W001	S	S	S	Y					S	Y					
667	W002	S	S	S	Y					S	Y					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.16.3
Methods Run at SWMU 667 (Includes SWMU 138)
Shallow Groundwater, Sampling Round 02

Site	Location	Metal	SVOA	VOA	Cn	Hexac	Dioxin	Oppe	Herb	Pest	Tph	Tph GR	Tph DR	Wq I	Wq II	Phys
667	W001	S		S												
667	W002	S		S												

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series
VOA:	Volatile Organics: Method 8240
SVOA:	Semi-volatile Organics: Method 8270
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)
Hexac:	Hexavalent Chromium: Method 7195
Dioxin:	Dioxins: Method 8290
Oppe:	Organophosphate Pesticides: Method 8140
Herb:	Chlorinated Herbicides: Method 8150
Pest:	Chlorinated Pesticides: Method 8080
Tph:	Total Petroleum Hydrocarbons: Method 418.1
Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Wq I:	Wet Chemistry I Parameters
Wq II	Wet Chemistry II Parameters
Phys:	Physical Chemistry Parameters

KEY:

Y:	Analyzed for standard list
S:	Analyzed for parameters on SW-846 list
A:	Analyzed for parameters on Appendix IX list
B:	Analyzed for parameters on both the SW-846 and Appendix IX lists
	Blank value indicates this method of analysis was not performed

Table 6.2.16.4
SWMU 667 (Includes SWMU 138)
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	6/ 7	18.90 - 18.90	34.000 - 120.000	64.750	780000.0000			
Aluminum	MG/KG	7/ 7		1820.000 - 4490.000	3384.285	7800.0000		25310.000	
Antimony	MG/KG	2/ 7	1.20 - 5.90	1.100 - 1.400	1.250	3.1000			
Arsenic	MG/KG	7/ 7		0.920 - 8.500	3.567	0.3700	7	14.810	
Barium	MG/KG	6/ 7	0.40 - 0.40	6.400 - 175.000	41.266	550.0000		40.330	2
* Benzo(a)pyrene Equivalents	UG/KG	7/ 7		87.200 - 174.400	99.657	88.0000	1		
Benzo(b)fluoranthene	UG/KG	1/ 7	330.00 - 780.00	214.000 - 214.000	214.000				
Benzo(a)pyrene	UG/KG	1/ 7	330.00 - 780.00	153.000 - 153.000	153.000				
Beryllium	MG/KG	7/ 7		0.030 - 0.935	0.232	0.1500	3	1.470	
2-Butanone (MEK)	UG/KG	2/ 7	10.00 - 29.00	6.900 - 9.000	7.950	4700000.0000			
Cadmium	MG/KG	2/ 7	0.14 - 0.72	0.350 - 0.360	0.355	3.9000		1.050	
Calcium	MG/KG	7/ 7		1300.000 - 202000.000	59760.000				
Carbon disulfide	UG/KG	1/ 7	5.00 - 6.00	4.600 - 4.600	4.600	780000.0000			
alpha-Chlordane	UG/KG	1/ 7	3.00 - 4.00	3.000 - 3.000	3.000	470.0000			
gamma-Chlordane	UG/KG	2/ 7	3.00 - 4.00	2.000 - 4.800	3.400	470.0000			
4-Chloro-3-methylphenol	UG/KG	1/ 7	330.00 - 780.00	72.000 - 72.000	72.000				
Chromium	MG/KG	7/ 7		3.100 - 56.700	15.328	39.0000	1	85.650	
Cobalt	MG/KG	7/ 7		0.280 - 3.400	1.544	470.0000		5.860	
Copper	MG/KG	7/ 7		1.600 - 39.850	13.478	290.0000		27.600	2
Cyanide	MG/KG	1/ 7	0.80 - 1.00	2.550 - 2.550	2.550	160.0000			
4,4'-DDD	UG/KG	3/ 7	7.00 - 2600.00	4.000 - 11.400	6.800	2700.0000			
4,4'-DDE	UG/KG	4/ 7	3.00 - 4.00	2.000 - 632.000	162.025	1900.0000			
4,4'-DDT	UG/KG	2/ 7	7.00 - 8.00	25.700 - 1140.000	582.850	1900.0000			
Di-n-butylphthalate	UG/KG	1/ 7	330.00 - 780.00	64.000 - 64.000	64.000	780000.0000			
1,1-Dichloroethane	UG/KG	1/ 7	5.00 - 6.00	10.000 - 10.000	10.000	780000.0000			
Dioxin (TCDD TEQ)	PG/G	2/ 2		2.041 - 6.689	4.365	1000.0000			
bis(2-Ethylhexyl)phthalate	UG/KG	2/ 7	330.00 - 400.00	310.000 - 480.000	395.000	46000.0000			
Fluoranthene	UG/KG	1/ 7	330.00 - 780.00	117.000 - 117.000	117.000	310000.0000			
Iron	MG/KG	7/ 7		1850.000 - 7460.000	4455.714			30910.000	
Lead	MG/KG	7/ 7		2.800 - 56.700	16.342	400.0000		118.000	
Magnesium	MG/KG	6/ 7	100.00 - 100.00	83.500 - 3150.000	1317.583			9592.000	
Manganese	MG/KG	7/ 7		7.900 - 152.000	63.842	39.0000	4	636.400	
Mercury	MG/KG	6/ 7	0.02 - 0.02	0.020 - 0.030	0.025	2.3000		0.490	
Methylene chloride	UG/KG	1/ 7	7.00 - 19.00	12.900 - 12.900	12.900	85000.0000			

Table 6.2.16.4
SWMU 667 (Includes SWMU 138)
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Nickel	MG/KG	5/ 7	5.70 - 6.50	1.700 - 9.300	3.960	160.0000		33.380	
Phenanthrene	UG/KG	2/ 7	370.00 - 780.00	50.800 - 55.800	53.300	310000.0000[k]			
Pyrene	UG/KG	1/ 7	330.00 - 780.00	89.100 - 89.100	89.100	230000.0000			
Sodium	MG/KG	7/ 7		17.100 - 331.000	98.628				
2,4,5-T	UG/KG	1/ 2	10.00 - 10.00	8.500 - 8.500	8.500	78000.0000			
2,4,5-TP (Silvex)	UG/KG	2/ 2		7.900 - 7.900	7.900	63000.0000			
* Petroleum Hydrocarbons, TPH	MG/KG	2/ 2		200.000 - 1800.000	1000.000	10.0000	2		
Toluene	UG/KG	4/ 7	5.80 - 6.00	2.300 - 13.135	8.358	1600000.0000			
Vanadium	MG/KG	7/ 7		6.000 - 15.500	10.971	55.0000		77.380	
Xylene (total)	UG/KG	1/ 7	5.00 - 6.00	2.400 - 2.400	2.400	16000000.0000			
Zinc	MG/KG	7/ 7		3.900 - 212.750	60.028	2300.0000		214.300	

Notes:
- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994
- j Based on proposed action level for soil and treatment technique action level for water
- k Fluoranthene used as surrogate

Table 6.2.16.5
SWMU 667 (Includes SWMU 138)
Shallow Groundwater, Sampling Round 01

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Barium	UG/L	2/ 2		12.900 - 61.400	37.150	260.0000		323.000	
Calcium	UG/L	2/ 2		113000.000 - 154000.000	133500.000				
Chloroethane	UG/L	1/ 2	5.00 - 5.00	150.000 - 150.000	150.000	860.0000			
1,1-Dichloroethane	UG/L	2/ 2		3.400 - 17.000	10.200	81.0000			
Iron	UG/L	2/ 2		86.200 - 361.000	223.600				
Magnesium	UG/L	2/ 2		90600.000 - 144000.000	117300.000				
Manganese	UG/L	2/ 2		36.700 - 58.200	47.450	18.0000	2	3391.000	
Potassium	UG/L	2/ 2		41600.000 - 66100.000	53850.000				
Sodium	UG/L	2/ 2		584000.000 - 1500000.000	1042000.000				

Notes:

* Retained as a chemical of potential concern

a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.16.6
SWMU 667 (Includes SWMU 138)
Shallow Groundwater, Sampling Round 02

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Barium	UG/L	2/ 2		18.200 - 47.900	33.050	260.0000		323.000	
Calcium	UG/L	2/ 2		81900.000 - 114000.000	97950.000				
Chloroethane	UG/L	1/ 2	5.00 - 5.00	74.000 - 74.000	74.000	860.0000			
1,1-Dichloroethane	UG/L	1/ 2	5.00 - 5.00	9.000 - 9.000	9.000	81.0000			
Iron	UG/L	2/ 2		38.600 - 853.000	445.800				
Magnesium	UG/L	2/ 2		121000.000 - 232000.000	176500.000				
Manganese	UG/L	2/ 2		68.900 - 155.000	111.950	18.0000	2	3391.000	
Potassium	UG/L	2/ 2		25300.000 - 91800.000	58550.000				
Sodium	UG/L	2/ 2		1220000.000 - 2580000.000	1900000.000				
Vanadium	UG/L	2/ 2		3.400 - 5.300	4.350	26.0000			

Notes:

- * Retained as a chemical of potential concern
- a USEPA Region III Residential Risk-Based Screening Value, March 1994

Table 6.2.16.7
Exposure Pathways Summary — AOC 667
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for SWMU 667, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 667.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 667.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for SWMU 667, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Risk-based screening was performed on shallow groundwater data. No COPCs were identified at this site. Therefore, shallow groundwater was not addressed formally.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Risk-based screening was performed on shallow groundwater data. No VOCs were identified as shallow groundwater COPCs at this site.
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.

Table 6.2.16.7
Exposure Pathways Summary — AOC 667
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.16.8
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOCs 667/138
Naval Base Charleston
Charleston, SC

Chemical	TEF	Fraction Ingested from Contaminated Source	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene equivalents	1	0.2	0.174	4.78E-08	4.46E-07	5.46E-08	1.71E-08	6.09E-09

NOTES:

TEF toxic equivalency factor relative to Benzo(a)pyrene
lwa lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 6.2.16.9
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOCs 667/138
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source	Dermal Absorption Factor (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene equivalents	1	0.174	0.2	0.01	1.96E-08	6.47E-08	1.23E-08	1.40E-08	5.00E-09

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.16.10
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOCs 667/138
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	4.0E-07	ND	4.4E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.16.11
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOCs 667/138
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	1.8E-07	ND	7.3E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.16.12
Summary of Risk and Hazard for SWMU 138/AOC 667
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	4.0E-07	ND	4E-08
	Dermal Contact	ND	ND	2.0E-07	ND	7E-08
Sum of All Pathways		ND	ND	6E-07	ND	1.1E-07

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

6.2.17 Baseline Risk Assessment for Other Impacted Areas

6.2.17.1 Site Background and Investigative Approach

Section 4, Nature of Contamination, discusses the grid-based reference location sampling effort. It describes three areas where significant surface soil impacts were noted in grid samples. The three areas are located around grid soil sample locations GDHSB007, GDHSB038 and GDHSB080. The following paragraphs discuss the original samples as well as supplemental samples collected to delineate soil impacts. Preliminary risk assessments were based on the available data for each area, although no past or current RCRA units are known to be close by. Due to the similarities in contaminants between impacted grid locations, their risk assessment presentations are combined here.

Grid location GDHSB007 (G07) is at the west entrance to the Building 644 parking lot in a grassy apron along Dyess Avenue. Aroclor-1260 and BEQs were present in the sample at concentrations above regulatory action limits. Based on these findings, two additional surface soil samples (G07SB00101 and G07SB00201) were collected and analyzed. Table 6.2.17.1 lists each surface soil designation and the analytical methods used. Groundwater was not sampled at this site.

Grid location GDHSB038 (G38) is approximately 70 feet southeast of Building NS-84 adjacent to the associated parking lot. Aroclor-1260 and BEQs were present in the sample at concentrations above regulatory action limits. Based on these findings, three additional surface soil samples (G38SB00101, G38SB00201, and G38SB00301) were collected and analyzed. Table 6.2.17.2 lists each surface soil designation and the analytical methods used. Groundwater was not sampled at this site.

Grid location GDHSB080 (G80) is located along the west edge of Building NS38. As discussed in Section 4, deep soil impacts were noted in a sample collected during the installation of grid monitoring well NBCHGDH04D. A sample collected from 7 feet deep, in the monitoring well boring, contained semivolatile compounds. Sample GDHSB080 also contained BEQs at concentrations exceeding the residential RBC. In response to the findings from the monitoring well boring, four supplemental surface soil locations were sampled and analyzed. These samples were G80SB00101, G80SB00201 and G80SB00301. Table 6.2.17.3 lists each surface soil designation and the analytical methods used. Groundwater was not sampled at this site.

6.2.17.2 COPC Identification

Soil

Surface soil data and screening values used in the screening comparison for G07, G38, and G80 are provided in Tables 6.2.17.4, 6.2.17.5 and 6.2.17.6. Due to the nature of the areas under investigation, supplemental sample analyses were restricted to methods required to detect contaminants at elevated concentrations in the original impacted grid samples.

In areas G07 and G38, Aroclor-1260 and BEQs were identified as COPCs. At area G80, only BEQs were COPCs.

6.2.17.3 Exposure Assessment

Exposure Setting

The most prominent features at locations G07 and G38 are the parking areas and Dyess Avenue. Very little land is unpaved in these areas, and each sample was collected adjacent to or through asphalt.

Near location G80, Building NS38 (former barracks) is the most prominent feature. Osprey Street runs west of G80 and Hobson Avenue runs north of NS38. In addition to roadways, numerous sidewalks cross the expanded grid location investigative area.

The future use of the areas in question is not definitive; however, it is anticipated that each will serve a commercial/industrial purpose. A marine cargo terminal is proposed for most of the north section of Zone H in current base reuse plans.

Potentially Exposed Populations

Potentially exposed populations include current and future site workers as well as hypothetical future site residents. Because many traditional activities at NAVBASE have ceased or are expected to cease in the near future, current site workers were not specifically addressed in the formal assessment. Due to the lack of specific knowledge regarding the functions that will be performed by future site workers, a standard default scenario was developed for these individuals. A similar approach was applied for future site residents.

Exposure Pathways

Exposure pathways for future site workers and site residents were based on an evaluation of the impacted media identified at locations G07, G38, and G80. Relative to the soil matrix, incidental ingestion and dermal contact were considered viable exposure pathways. Groundwater exposure pathways were not considered for these areas. Uniform exposure was assumed for all sample locations in the standard assessment. The influences of existing features on the potential for exposure are discussed where appropriate. Table 6.2.17.7 presents the exposure pathway selection process and justifications for each of the pathways evaluated.

Exposure Point Concentrations

Due to the limited sampling in each area, the maximum concentrations of each COPC were applied as the EPCs on a preliminary basis. In some instances, contaminant extent has not been fully achieved. Because no source of contamination has been reported or confirmed in the areas described, supplemental sampling was not focused on any specific area; delineation sampling requirements for affected areas could not be accurately predicted.

At G07, significantly elevated concentrations of Aroclor-1260 were reported in supplemental sample G07SB00101. As shown in Section 4, the detection of Aroclor-1260 in this sample indicates that the southern and western extent of the impacted area have not been defined. It is not certain whether definition of impacts was achieved at area G38. The western extent was apparently bounded by sample G38SB00201, but appreciable concentrations of Aroclor-1260 were detected in samples collected north and south of the original grid location. The western and southern extent of BEQs impacts were defined by supplemental sampling at location G80. Concentrations in exceeding residential RBC were, however, detected north of GDHSB080 in sample G80SB00301 and east of Building NS38 in sample G80SB00401, although the exceedances were relatively slight.

Because the extent of surface soil impacts is not fully characterized, the exposure quantification and resultant risk/hazard results should be considered preliminary. It will be imperative to identify potential sources and achieve adequate delineation of each affected area before more definitive conclusions can be drawn.

Quantification of Exposure

Soil

Tables 6.2.17.8 and 6.2.17.9 present the CDI for the ingestion and dermal contact pathways, at location G07. Tables 6.2.17.10 and 6.2.17.11 present the CDI for the ingestion and dermal contact pathways, respectively, at location G38. Tables 6.2.17.12 and 6.2.17.13 present the CDI for the ingestion and dermal contact pathways, respectively, at location G80.

6.2.17.4 Toxicity Assessment

Aroclor-1260 and BEQs were identified as the only surface soil COPCs at impacted grid sampling locations. Table 6.2.17.14 presents toxicological values (slope factors and reference doses) used to project risk/hazard based on computed CDI as well as discussions of the potential toxic effects and target organs for each. The following paragraphs present the brief toxicological profiles for each COPC.

Polyaromatic hydrocarbons include the following COPCs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of BAP, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC Table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, (search date 6/28/95), the basis for the BAP B2 classification is human data specifically linking BAP to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating BAP to be carcinogenic following administration by numerous routes.

BAP has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for BAP was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question: the

USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1 million. The Carcinogenicity Background Document details the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity. As listed in IRIS (search date 6/28/95), the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting.

As listed in IRIS, the basis for the BAP B2 classification is no human data and sufficient data from animal bioassays. BAP produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. BAP produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene mutates in bacteria. (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as ***pyrene***, ***acenaphthene***, ***acenaphthylene***, ***benzo(g,h,i)perylene***, and ***phenanthrene***. USEPA determined RfDs for only two of these compounds: pyrene's RfD_o of 0.03 mg/kg-day, is also used as a surrogate RfD_o for phenanthrene. The RfD_o for acenaphthene was determined to be 0.06 mg/kg-day.

PCB Aroclors are a group of chlorinated hydrocarbons (such as ***Aroclor-1248, 1254, and 1260***) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme levels, rashes and chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA classified PCB Aroclors as group B2 carcinogens, primarily based on animal data. As listed in IRIS, the basis for the classification is hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate yet suggestive evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. USEPA set 7.7 $(mg/kg\text{-}day)^{-1}$ as the SF_o for PCB Aroclors, and oral RfDs have been set at 0.00007 mg/kg-day for Aroclor-1016 and 0.00002 mg/kg-day for Aroclor-1254.

6.2.17.5 Risk Characterization

Surface Soil Exposure Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) land use scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were considered. For noncarcinogenic chemicals evaluated for future site residents, HQs were computed separately to address children and adults. Tables 6.2.17.15 through 6.2.17.20 present the computed carcinogenic risk and noncarcinogenic HQs associated with the incidental ingestion and dermal contact with surface soil for impacted grid sampling locations G07, G38 and G80.

Impacted Area G07

Future Site Residents

The projected ingestion-related ILCR from surface soil was 4E-5 and the dermal pathway risk was 2E-5. Aroclor-1260 accounts for more than 90% of the projected risk for both pathways, and BEQs contributed the remainder. Noncarcinogenic hazard was not projected for either compound, because no toxicological reference doses are available.

Future Site Workers

The projected ingestion-related ILCR from surface soil was 4E-6 and the dermal pathway risk was 7E-6. Aroclor-1260 accounts for more than 90% of the projected risk for both pathways, and BEQs contributed the remainder. Noncarcinogenic hazard was not projected for either compound, because no toxicological reference doses are available.

The maximum Aroclor-1260 and BEQs were reported in the original grid sample. As mentioned earlier, this sample was collected in a grass-covered road apron area adjacent to the Building 644 parking lot. Although no existing site feature would serve to preclude soil contact, the frequency of contact would be restricted by location. It is most likely that the individuals subject to the most frequent exposure would be engaged in lawn maintenance activities. It was noted earlier that the full extent of soil impacts has not been determined. The presence of Aroclor-1260 or BEQs in areas immediately surrounding impacted sampling locations would not significantly affect direct contact exposure potential. If the existing asphalt surfaces remain intact under future site uses, any currently inaccessible impacted surface soil would not add to the computed CDIs.

Impacted Area G38

Future Site Residents

The projected ingestion-related ILCR from surface soil was 5E-5, and the dermal pathway risk was 2E-5. Aroclor-1260 accounts for more than 90% of the projected risk for both pathways, and BEQs contributed the remainder. Noncarcinogenic hazard was not projected for either compound, because no toxicological reference doses are available.

Future Site Workers

The projected ingestion-related ILCR from surface soil was 6E-6, and the dermal pathway risk was 9E-6. Aroclor-1260 accounts for more than 90% of the projected risk for both pathways, and BEQs contributed the remainder. Noncarcinogenic hazard was not projected for either compound, because no toxicological reference doses are available.

The maximum Aroclor-1260 and BEQs concentrations were reported in the original grid sample. This sample was collected in a grass-covered median adjacent to the Building NS-84 parking lot. Although no current site feature would preclude soil contact at this location, the frequency of contact would be restricted by location. It is most likely that the individuals subject to the most frequent exposure would be engaged in lawn maintenance activities. It was noted earlier that the full extent of soil impacts has not been determined. The presence of Aroclor-1260 or BEQs in areas immediately surrounding impacted sampling locations would not necessarily affect direct contact exposure potential. If the existing asphalt surfaces remain intact under future site uses, any currently inaccessible impacted surface soil east of the original sampling location would not add to the computed CDIs. Any exposed surface soil impacts west and south of GDHSB038 could, however, influence exposure projections and thus resultant risk/hazard estimates.

Impacted Area G80

Future Site Residents

The projected ingestion related ILCR from surface soil was 3E-6 and the dermal pathway risk was 1E-6. BEQs were the only contributors for both pathways. Noncarcinogenic hazard was not projected for BEQs because no toxicological reference dose is available.

Future Site Workers

The projected ingestion-related ILCR from surface soil was 3E-7 and the dermal pathway risk was 6E-7. BEQs were the only contributors for both pathways. Noncarcinogenic hazard was not projected for BEQs because no toxicological reference dose is available.

Because site worker risk projections did not exceed the most conservative 1E-6 point of departure assuming that all surface soil was accessible for contact exposure, no formal assessment was necessary, considering the influences of existing site features or FI/FC. The area in and around Building NS-38 and grid location GDHSB080 can be characterized as bare ground, vegetated soil, and asphalt/cement surfaces. The samples in which BEQs were detected

Impacted Area G38

Hypothetical Site Residents

Aroclor-1260 and BEQs were tentatively identified as COCs for this scenario based on the sum ILCR.

Hypothetical Site Workers

Aroclor-1260 and BEQs were tentatively identified as COCs for this scenario based on the sum ILCR.

Impacted Area G80

Hypothetical Site Residents

BEQs were tentatively identified as COCs for this scenario based on the sum ILCR.

Hypothetical Site Workers

No COCs were identified for this scenario based on the sum ILCR and HI.

6.2.17.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Under current site use conditions, workers may be infrequently exposed to surface soil sampled during the RFI when walking across affected areas, or when engaged in lawn maintenance activities. Based on current operations, however, the potential for extended or typically defined chronic exposure is considered very low.

were collected close to two main thoroughfares in the northeast section of Zone H. The presence of BEQs in areas immediately surrounding impacted sampling locations would not necessarily affect direct contact exposure potential. If the existing asphalt surfaces remain intact under future site uses, any currently inaccessible impacted surface soil east of the original sampling location would not add to the computed CDIs.

COCs Identified

Based on the evaluation of surface soil exposure pathways presented above, COCs were identified in surface soil at each impacted grid sampling location. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a hazard index above 1.0, if its individual ILCR exceeds 1E-6 or its hazard quotient exceeds 0.1. For carcinogens, this approach is comparatively conservative, because a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection algorithm presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development. Because soil was the only medium sampled in these areas, COC identification is limited. If the traditional 1E-4 ILCR trigger were applied to risk projections for impacted grid sampling locations, no COCs would be identified.

Impacted Area G07

Hypothetical Site Residents

Aroclor-1260 and BEQs were tentatively identified as COCs for this scenario based on the sum ILCR.

Hypothetical Site Workers

Aroclor-1260 was identified as a COC for this scenario based on the sum ILCR.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current plans call for continued use of most parcels close to impacted grid sampling locations as nonresidential, specifically a marine cargo terminal. Building NS-38, next to G80, could serve as short-term to moderate-term housing for culinary students, according to some reports.

To develop the site for residential purposes, the asphalt road and parking surfaces would be removed. There is a high probability that the cPAHs detected in surface soil are associated with these materials. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Conditions do exist at impacted grid locations that could result in enhanced exposure potential if the parcel is developed for residential purposes. Because the extent of surface soil impacts have not been fully delineated, currently inaccessible and as yet unknown impacted surface soil areas could be exposed when existing features (e.g.. roads, parking lots, buildings) are razed. If this happens, estimates of reasonable maximum exposure may be substantially influenced.

Determination of Exposure Point Concentrations

The maximum concentration reported for each COPC was conservatively applied as the exposure point concentration for each impacted grid sampling location. Based on currently available information, this approach was considered the most prudent means of providing an estimate of reasonable maximum exposure.

Frequency of Detection and Spatial Distribution

At location G07, Aroclor-1260 was detected in two of three samples and BEQs were detected in each sample. No detailed assessment of spatial distribution is possible because the extent of surface soil impacts have not been fully delineated and the source of the identified contaminants is unknown. It can be concluded that BEQs were found in relatively low concentrations, ranging from below to 2.5 times the residential RBC. Asphalt surfaces close to each sampling location at G07 are possible sources of these cPAHs in surface soil.

At location G38, Aroclor-1260 was detected in two of four surface soil samples and BEQs were detected in one sample (G38SB00301). No detailed assessment of Aroclor-1260's spatial distribution is possible because the extent of surface soil impacts have not been fully delineated and the source is unknown. BEQs were detected in a sample collected next to the Building NS-84 parking lot. This asphalt surface is a possible source of these cPAHs in surface soil.

BEQs were the only COCs identified in impacted grid area G80, and were detected in four of five samples. Concentrations reported were relatively low, ranging from 1.2 to 3 times the residential RBC. Asphalt surfaces close to each sampling location at G80 are possible sources of these cPAHs in surface soil.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in risk assessment is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

The samples in which BEQs were detected were from directly beneath or close to asphalt surfaces. Benzo(a)pyrene and other cPAHs are constituents of asphalt and their presence is not necessarily attributable to past or current site operation.

Although the future land use of the impacted grid sampling locations is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard.

The central tendency assumption for residential exposure duration is 9 years compared to the 30-year assumption for RME. The CT exposure frequency for residents is 234 days/year versus 350 days/year under RME. CDI and resultant ILCR projections are linearly related to both exposure duration and frequency assumptions. If all other exposure assumptions remain fixed, application of the CT exposure duration and frequency assumptions would result in risk projections 80% below the RME estimates. Worker CT assumptions for exposure duration and frequency are 5 years and 219 days/year as opposed to 25 years and 250 days/year at RME. Application of these worker assumptions fixing all other formula inputs results in risk projections more than 80% below the RME. The following paragraphs discuss the implications of CT assumptions on risk projections for each impacted grid sampling area.

Impacted Area G07

The cumulative RME ILCR for future resident incidental ingestion and dermal contact soil pathways was computed to be 5E-5 at G07. Application of CT assumptions would result in a revised estimate of 1E-5. Additionally, benzo(a)pyrene equivalents would not be identified as COCs under CT conditions. For future site workers, the cumulative RME ILCR for incidental ingestion and dermal contact soil pathways was computed to be 1E-5. Under CT conditions, the future worker ILCR was estimated at 2E-6.

Impacted Area G38

The cumulative RME ILCR for future resident incidental ingestion and dermal contact soil pathways was computed to be 8E-5 at G38. Application of CT assumptions would result in a revised estimate of 2E-5. For future site workers, the cumulative RME ILCR for incidental ingestion and dermal contact soil pathways was computed to be 2E-5. Under CT conditions, the future worker ILCR was estimated at 3E-6.

Impacted Area G80

The cumulative RME ILCR for future resident incidental ingestion and dermal contact soil pathways was computed to be 4E-6 at G80. Application of CT assumptions would result in a revised estimate of 9E-7. This CT ILCR estimate is below the USEPA and SCDHEC 1E-6 point of departure. As a result, no surface soil COCs would be identified under residential CT conditions. For future site workers, the cumulative RME ILCR for incidental ingestion and dermal contact soil pathways was computed to be 9E-7. This RME ILCR estimate is below the USEPA and SCDHEC 1E-6 point of departure. As a result, no surface soil COCs would be identified under worker RME conditions. Under CT conditions, the future worker ILCR falls below the point of departure.

6.2.17.7 Risk Summary

The risk and hazard posed by contaminants at each impacted grid sampling location were assessed for the hypothetical RME site worker and the hypothetical future site resident. In surface soil, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 6.2.17.21 summarizes risk for the combined incidental ingestion and dermal pathways for each area.

6.2.17.8 Remedial Goal Options

Soil

The COCs identified at impacted grid sampling locations were relatively consistent. As a result, a single set of remedial goal options was calculated for the future site resident and workers based on the RME risk estimates for each receptor group presented in Section 6.2.18.5. Residential-scenario based RGOs are presented in Table 6.2.17.22. Worker-scenario based RGOs are presented in Table 6.2.17.23.

Table 6.2.17.1
Methods Run at Other Impacted Area: G07
Surface Soil

Site	Location	Metal	Pest	Svoa	Voa	Cn	Dioxin	Oppe	Herb	Hexac	Tph	Tphgr	8100	Wq I	Wq II	Phys
G07	B001		S	S												
G07	B002		S	S	S											
GDH	G007-01	B	B	B	B	Y	Y	Y	A	Y	A					

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
		Tph:	Total Petroleum Hydrocarbons: Method 418.1
VOA:	Volatile Organics: Method 8240	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
SVOA:	Semi-volatile Organics: Method 8270		
Cn:	Cyanide (Soil: Method 9010, Water; Method 9012)	TPH DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II:	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.17.2
Methods Run at Other Impacted Area: G38
Surface Soil

Site	Location	Metal	Pest	Svoa	Voa	Cn	Dioxin	Oppe	Herb	Hexac	Tph	Tphgr	8100	Wq I	Wq II	Phys
G38	B001		S													
G38	B002		S													
G38	B003		S	S												
GDH	B38	S	S	S	S	Y										

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Methods: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
		Tph:	Total Petroleum Hydrocarbons: Method 418.1
VOA:	Volatile Organics: Method 8240	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
SVOA:	Semi-volatile Organics: Method 8270		
Cn:	Cyanide (Soil: Method 9010, water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	WQ II:	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

Y: Analyzed for standard list
S: Analyzed for parameters on SW-846 list
A: Analyzed for parameters on Appendix IX list
B: Analyzed for parameters on both the SW-846 and Appendix IX lists
Blank value indicates this method of analysis was not performed

Table 6.2.17.3
Methods Run at Other Impacted Area: G80
Surface Soil

Site	Location	Metal	Pest	Svoa	Voa	Cn	Dioxin	Oppe	Herb	Hexac	Tph	Tphgr	8100	Wq I	Wq II	Phys
G80	B001			S	S											
G80	B002			S	S											
G80	B003			S	S											
G80	B004	A	A	B	B	Y	Y	Y	A	Y	A					
GDH	B080	S	S	S	S	Y										

METHODS:

Metal:	TAL (Target Analyte List) Metals plus tin: Method: 6000/7000 Series	Pest:	Chlorinated Pesticides: Method 8080
VOA:	Volatile Organics: Method 8240	Tph:	Total Petroleum Hydrocarbons: Method 418.1
SVOA:	Semi-volatile Organics: Method 8270	Tph GR:	Total Petroleum Hydrocarbons with Gasoline Range Organics Extraction Method 5030, GC Method 8015
Cn:	Cyanide (Soil: Method 9010, Water: Method 9012)	Tph DR:	Total Petroleum Hydrocarbons with Diesel Range Organics Extraction Method 3550, GC Method 8100
Hexac:	Hexavalent Chromium: Method 7195		
Dioxin:	Dioxins: Method 8290	Wq I:	Wet Chemistry I Parameters
Oppe:	Organophosphate Pesticides: Method 8140	Wq II:	Wet Chemistry II Parameters
Herb:	Chlorinated Herbicides: Method 8150	Phys:	Physical Chemistry Parameters

KEY:

- Y: Analyzed for standard list
- S: Analyzed for parameters on SW-846 list
- A: Analyzed for parameters on Appendix IX list
- B: Analyzed for parameters on both the SW-846 and Appendix IX lists

Blank value indicates this method of analysis was not performed

Table 8.2.17.4
Other Impacted Area: G07
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
* Aroclor-1260	UG/KG	2/3	40.000 - 40.000	970.000 - 2820.000	2820.0000	83.0000	1		
Benzo(g,h,i)perylene	UG/KG	1/3	390.000 - 390.000	150.000 - 150.000	150.0000	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	2/3		69.000 - 244.700	146.9000	88.0000	1		
Benzo(b)fluoranthene	UG/KG	2/3	430.000 - 430.000	140.000 - 218.000	179.0000				
Benzo(a)pyrene	UG/KG	2/3	390.000 - 390.000	110.000 - 197.000	153.5000				
Benzo(a)anthracene	UG/KG	1/3		195.000 - 195.000	195.0000				
Benzo(k)fluoranthene	UG/KG	2/3		219.000 - 219.000	219.0000				
Chrysene	UG/KG	1/3		236.500 - 236.500	236.5000				
Indeno (1,2,3-cd)pyrene	UG/KG	1/3		105.500 - 105.500	105.5000				
bis(2-Ethylhexyl)phthalate	UG/KG	1/3	430.000 - 430.000	93.000 - 93.000	46000.0000	46000.0000			
Flouranthene	UG/KG	2/2		110.000 - 120.000	115.0000	310.0000			
Pyrene	UG/KG	1/3	430.000 - 430.000	93.000 - 93.000	93.0000	230.0000			
4,4'-DDT	UG/KG	1/3		140.000 - 140.000	140.0000				
Dioxin (TCDD TEQ)	PG/G	1/1		14.250 - 14.50	14.2500	1.0000			

Table 6.2.17.5
Other Impacted Area: C38
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref
* Aroclor-1260	UG/KG	2/4	40.000 - 50.000	1100.000 - 4000.000	1100.0000	83.0000	1		
Benzo(g,h,i)perylene	UG/KG	1/1		140.000 - 140.000	140.0000	310000.0000f			
* Benzo(a)pyrene Equivalents	UG/KG	1/2		317.720 - 317.720	317.7200	88.0000	1		
Benzo(b)fluoranthene	UG/KG	1/2		190.000 - 190.000	190.0000				
Benzo(a)pyrene	UG/KG	1/2		320.000 - 320.000	320.0000				
Chrysene	UG/KG	1/2		320.000 - 320.000	320.0000				
Indeno (1,2,3-cd)pyrene	UG/KG	1/2		140.000 - 140.000	140.0000				
Benzo(k)fluoranthene	UG/KG	1/2		240.000 - 240.000	240.0000				
Benzo(a)pyrene	UG/KG	1/2		250.000 - 250.000	250.0000				
Flouranthene	UG/KG	1/2		690.000 - 690.000	390.0000	310000.0000			
Phenanthrene	UG/KG	1/2		350.000 - 350.000	350.0000	310000.0000k			
Pyrene	UG/KG	1/2		500.000 - 500.000	500.0000	230000.0000			
4,4'-DDT	UG/KG	1/4		180.000 - 180.000	180.0000				
4,4'-DDE	UG/KG	1/4		19.000 - 19.000	19.0000				

Table 8.2.17.8
Other Impacted Area: [illegible]
Surface Soil

Parameter	Units	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Conc.	Screening Conc.	Num. Over Screen	Reference Conc.	Num. Over Ref.
Acetone	UG/KG	1/4	12.000 - 33.000	160.000 - 160.000	160.0000	780000.0000			
Anthracene	UG/KG	1/4	333.000 - 380.000	90.000 - 90.000	90.0000	2300000.0000			
Arsenic	MG/KG	1/1		11.700 - 11.700	11.7000	0.3700	1	14.81	
Barium	MG/KG	1/1		26.100 - 26.100	26.1000	550.0000		40.33	
* Benzo(a)pyrene Equivalents	UG/KG	5/5		48.597 - 263.430	130.6000	88.0000	2		
Benzo(a)anathracene	UG/KG	4/5	380.000 - 380.000	64.400 - 220.000	135.1000				
Benzo(b)fluoranthene	UG/KG	4/5	380.000 - 380.000	115.000 - 300.000	196.2500				
Chrysene	UG/KG	4/5	380.000 - 380.000	85.000 - 230.000	147.7000				
Benzo(k)fluoranthene	UG/KG	3/5	380.000 - 380.000	66.900 - 140.000	105.6300				
Benzo(a)pyrene	UG/KG	3/5	380.000 - 380.000	78.500 - 200.000	139.5000				
Indeno (1,2,3-cd)pyrene	UG/KG	1/5	380.000 - 380.000	98.000 - 98.000	98.0000				
Beryllium	MG/KG	1/1		0.690 - 0.690	0.6900	0.1500	1	1.47	
Cadmium	MG/KG	1/1		0.410 - 0.410	0.4100	3.9000		1.05	
Chromium	MG/KG	1/1		29.300 - 29.300	29.3000	39.0000		85.65	
Copper	MG/KG	1/1		21.200 - 21.200	21.2000	290.0000		27.60	
Dieldrin	UG/KG	1/1		2.600 - 2.600	2.6000	40.0000			
Dioxin (TCDD TEQ)	PG/G	1/1		13.362 - 13.362	13.3622	1000.0000			
Endrin aldehyde	UG/KG	1/1		4.400 - 4.400	4.4000	2300.0000h			
bis(2-Ethylhexyl)phthalate	UG/KG	2/4	370.000 - 380.000	70.600 - 70.600	90.3000	46000.0000			
Fluoranthene	UG/KG	3/4	380.000 - 380.000	135.000 - 510.000	285.0000	310000.0000			
* Intermediate Lubricating Oil	UG/KG	1/1		15700.000 - 15700.000	15700.0000	10.0000	1		
Lead	MG/KG	1/1		40.500 - 40.500	40.5000	400.0000j		118.00	
Mercury	MG/KG	1/1		0.190 - 0.190	0.1900	2.3000		0.49	
Nickel	MG/KG	1/1		8.300 - 8.300	8.3000	160.0000		33.38	
Phenanthrene	UG/KG	3/4	380.000 - 380.000	61.500 - 430.000	210.5000	310000.0000k			
Pyrene	UG/KG	3/4	380.000 - 380.000	99.900 - 350.000	203.3000	230000.0000			
Selenium	MG/KG	1/1		1.300 - 1.300	1.3000	39.0000		2.00	
2,4,5-TP (Silvex)	UG/KG	1/1		12.200 - 12.200	12.2000	63000.0000			
Toluene	UG/KG	1/4	6.000 - 9.000	2.900 - 2.900	2.9000	1600000.0000			
Vanadium	MG/KG	1/1		38.800 - 38.800	38.8000	55.0000		77.38	
Zinc	MG/KG	1/1		148.000 - 148.000	148.0000	2300.0000		214.30	

Table 6.2.17.7
Exposure Pathways Summary — Other Impacted Areas
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for other impacted areas, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at other impacted areas.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at other impacted areas.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Based on the COPCs identified in this BRA for other impacted areas, no significant VOC concentrations were identified at this site.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Exposure to dust generated by site users traversing the area would be minimized by paved and/or vegetated soils.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Risk-based screening was performed on shallow groundwater data. No COPCs were identified at this site. Therefore, shallow groundwater was not addressed formally.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Risk-based screening was performed on shallow groundwater data. No VOCs were identified as shallow groundwater COPCs at this site.

Table 6.2.17.7
Exposure Pathways Summary — Other Impacted Areas
Naval Base Charleston
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential and site worker scenarios. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Soil, Dermal contact	Yes	Current soil conditions were assessed for the hypothetical residential scenario. However, any future construction activities would likely include clean soil being placed on top of current surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 6.2.17.8
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC G07
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1260	NA	2.820	3.86E-06	3.61E-05	4.41E-06	1.38E-06	4.93E-07
Benzo(a)pyrene Equivalents	1	0.245	3.35E-07	3.13E-06	3.83E-07	1.20E-07	4.28E-08

NOTES:

lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
-	exposure point concentrations were adjusted to equivalent concentrations by their corresponding TEF

Table 6.2.17.9
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC G07
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1260	NA	2.820	0.01	1.58E-06	5.23E-06	9.91E-07	1.13E-06	4.04E-07
Benzo(a)pyrene Equivalents	1	0.245	0.01	1.37E-07	4.54E-07	8.60E-08	9.82E-08	3.51E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.17.10
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC G38
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1260	NA	4.000	5.48E-06	5.11E-05	6.26E-06	1.96E-06	6.99E-07
Benzo(a)pyrene Equivalents	1	0.318	4.35E-07	4.06E-06	4.97E-07	1.55E-07	5.55E-08

NOTES:

lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
*	exposure point concentrations were adjusted to equivalent concentrations by their corresponding TEF

Table 6.2.17.11
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC G38
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Aroclor-1260	NA	4.000	0.01	2.25E-06	7.42E-06	1.41E-06	1.60E-06	5.73E-07
Benzo(a)pyrene Equivalents	1	0.318	0.01	1.78E-07	5.89E-07	1.12E-07	1.27E-07	4.55E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

Table 6.2.17.12
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil (0-1')
AOC G80
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.263	3.61E-07	3.37E-06	4.12E-07	1.29E-07	4.60E-08

NOTES:

lwa	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
-	exposure point concentrations were adjusted to equivalent concentrations by their corresponding TEF

Table 6.2.17.13
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil (0-1')
AOC G80
Naval Base Charleston
Charleston, SC

Chemical	TEF	Adjusted Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (ABS) (unitless)	Potential Future Resident adult H-CDI (mg/kg-day)	Potential Future Resident child H-CDI (mg/kg-day)	Potential Future Resident lwa C-CDI (mg/kg-day)	Potential Current Worker adult H-CDI (mg/kg-day)	Potential Current Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.263	0.01	1.48E-07	4.88E-07	9.26E-08	1.06E-07	3.77E-08

NOTES:

CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
-	The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

le 6.2.17.14 - Other Impacted Areas
icological Database Information
:hemicals of Potential Concern
/BASE Charleston, Zone H

Non-Carcinogenic Toxicity Data

mical	Oral Reference Dose (mg/kg/day)	Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg/day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation
3 Aroclor-1260	ND			ND	ND			ND
zo(a)pyrene Equivalents	ND			ND	ND			ND

NOTES:

a Integrated Risk Information System (IRIS)
g Provided by USEPA Region IV
Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.
NA Not applicable or not available
ND Not determined due to lack of information

able 6.2.17.14 - Other Impacted Areas
oxicological Database Information
r Chemicals of Potential Concern
AVBASE Charleston, Zone H

Carcinogenic Toxicity Data

hemical	Oral Slope Factor [(mg/kg/day)]-1		Inhalation Slope Factor [(mg/kg/day)]-1		Weight of Evidence	Tumor Type
CB Aroclor-1260	7.7		ND		B2	hepatocellular carcinoma
enzo(a)pyrene Equivalents	7.3	a	3.1	g	B2	mutagen

Table 6.2.17.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC G07
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1260	NA	7.7	ND	ND	3.4E-05	ND	3.8E-06
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.8E-06	ND	3.1E-07
SUM Hazard Index/ILCR			ND	ND	4E-05	ND	4E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.17.16
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC G07
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1260	0.5	NA	15.4	ND	ND	1.5E-05	ND	6.2E-06
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.3E-06	ND	5.1E-07
SUM Hazard Index/ILCR				ND	ND	2E-05	ND	7E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.17.17
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC G38
Naval Base Charleston
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1260	NA	7.7	ND	ND	4.8E-05	ND	5.4E-06
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	3.6E-06	ND	4.1E-07
SUM Hazard Index/ILCR			ND	ND	5E-05	ND	6E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.17.18
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC G38
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Aroclor-1260	0.5	NA	15.4	ND	ND	2.2E-05	ND	8.8E-06
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.6E-06	ND	6.6E-07
SUM Hazard Index/ILCR				ND	ND	2E-05	ND	9E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.17.19

Hazard Quotients and Incremental Lifetime Cancer Risks

Incidental Surface Soil Ingestion

AOC G80

Naval Base Charleston

Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	3.0E-06	ND	3.4E-07

NOTES:

NA Not available

ND Not Determined due to lack of available information

lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A

ILCR Incremental Lifetime excess Cancer Risk

Table 6.2.17.20
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC G80
Naval Base Charleston
Charleston, SC

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Potential Future Resident adult Hazard Quotient	Potential Future Resident child Hazard Quotient	Potential Future Resident lwa ILCR	Potential Current Worker adult Hazard Quotient	Potential Current Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.4E-06	ND	5.5E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 6.2.17.21
Summary of Risk and Hazard for Other Impacted Areas
NAVBASE - Charleston Zone H
Charleston, South Carolina

Medium	Exposure Pathway	Potential Future Resident Adult HI	Potential Future Resident Child HI	Potential Future Resident Iwa ILCR	Potential Future Site Worker HI	Potential Future Site Worker ILCR
G07						
Surface Soil	Incidental Ingestion	ND	ND	4E-05	ND	4E-06
	Dermal Contact	ND	ND	2E-05	ND	7E-06
Sum of All Pathways		ND	ND	6E-05	ND	1E-05
G38						
Surface Soil	Incidental Ingestion	ND	ND	5E-05	ND	6E-06
	Dermal Contact	ND	ND	2E-05	ND	9E-06
Sum of All Pathways		ND	ND	8E-05	ND	2E-05
G80						
Surface Soil	Incidental Ingestion	ND	ND	3E-06	ND	3E-07
	Dermal Contact	ND	ND	1E-06	ND	6E-07
Sum of All Pathways		ND	ND	4E-06	ND	9E-07

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
NA indicates not applicable

Table 6.2.17.22
Residential-Based Remedial Goal Options
Naval Base Charleston, Impacted Grid Sampling Location Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	**Risk-Based Remedial Goal Options** **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Aroclor-1260	7.7	NA	2.820	0.057	0.57	5.7	ND
Benzo(a)pyrene Equivalents	7.3	1	0.245	0.060	0.60	6.0	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 6.2.17.23
Worker-Based Remedial Goal Options
Naval Base Charleston, Impacted Grid Sampling Location Surface Soils
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	TEF	Unadjusted EPC mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Aroclor-1260	7.7	NA	2.820	0.282	2.82	28.2	ND
Benzo(a)pyrene Equivalents	7.3	1	0.245	0.297	2.97	29.7	ND

NOTES:
EPC exposure point concentration
NA not applicable
ND not determined